

Chapter 5

GREAT LAKES AND SALTWATER RECREATIONAL FISHING: DATA

The approach employed for estimating the benefits of pollution control as they accrue via Great Lakes and saltwater recreational fishing recognizes that changes in prices (due to changes in water pollution) have a two-fold effect on demand. The first effect is on the probability of participation in the activity of interest, while the second is on the intensity of participation, given that a consumer has decided to participate. This follows models developed by Cragg (Cragg, 1971) and Tobin (Tobin, 1958), frequently referred to as “hurdles” models. (See chapter 4, above). The model is similar to that employed in RFF’s study of freshwater fishing (Vaughan and Russell, 1982) and utilizes the same survey data, as will be seen below. The principal advantage of the two-stage model over simpler single-stage models is that, even in cases where the same exogenous variables are employed in both the probability-of-participation and the intensity-of-participation stages, the coefficients are permitted to vary between the two stages, allowing for a more general (and potentially more accurate) model specification/estimation.

Our discussion of Great Lakes and saltwater recreational fishing benefits is divided into three chapters. Here in chapter 5 we describe the formation of the database used in estimating the participation and intensity equations, and outline some of the problems with the data on pollution and availability of fishable water. In chapter 6 we describe the estimation of the probability of participation and intensity equations. In

chapter 7 we evaluate the changes in probabilities and intensities resulting from reduction in pollution attributable to the policy and combine the probability and intensity changes, along with estimates of average consumer surplus, to produce benefit estimates.

PARTICIPATION AND INTENSITY DATA

The survey data used in the models is taken from the 1975 National Survey of Hunting, Fishing and Wildlife-associated Recreation (NSHFWR75), done by the U.S. Fish and Wildlife Service (USFWS). For a general description of the survey, see U.S. Department of the Interior (n.d.), and Vaughan and Russell (1982), chapter 3. A discussion of the survey as it applies to Great Lakes and saltwater fishing follows.

The survey was conducted in two parts. The first stage was a telephone survey of 106,294 households (approximately 313,000 individuals) to determine whether or not anyone in each of the families contacted had engaged in any wildlife-related activities. In the second stage, a mail questionnaire was sent to each of the 56,575 individuals age nine or older who indicated that they were hunters or fishermen. While the telephone survey was quite brief and did not solicit detailed recreation participation data (i.e., individuals were asked if they had fished, but not the type of fishing they had done), the mail survey in the second stage was lengthy and asked very detailed questions about hunting and fishing activities.

In earlier work on freshwater fishing, we encountered three basic problems with the use of the two surveys. First, it was not possible to "locate" individual respondents geographically, at a finer level of geographic detail than their state of residence. Second, the survey was

"unbalanced" in that it was not a random sample of the entire U.S. population, but instead has roughly equal numbers of respondents per state; and within states it had a much higher proportion of non-metropolitan residents than was generally the case for the population at large of each respective state. Finally, it was not possible to "link" the two surveys.

The problem of the geographic location of the survey respondents was not very serious for the freshwater fishing study, but it would have been very serious for Great Lakes/saltwater fishing, since it would have been impossible to calculate the distance between a respondent's residence and the nearest Great Lake or the nearest ocean coast. Fortunately, after the freshwater study had been completed, we received a file from USFWS containing identifying numbers for both the telephone survey and mail survey respondents, and the first six digits (three-digit area code and three-digit exchange number) of each household's telephone number. (Obviously for individuals who did not participate in the mail survey there was no mail survey I.D. number). Since we had previously developed a database that linked telephone numbers and counties. (See appendix 5.A) for use with the boating survey data, described in chapter 10, below, we were able to "locate" each individual fairly accurately, to his or her county. Since the list from USFWS also contained a correspondence between the first stage telephone survey and the second stage mail survey, we could link the two, which was a requirement for estimating the probability of participation models, as will be seen below.

The problem of sample balance was somewhat more serious, because our samples of participants in Great Lakes/saltwater fishing were a small proportion of the total sample. For example, about 300 valid positive responses indicating Great Lakes fishing participation were received from

over 14,000 mail survey respondents who reported the details of their fishing experiences. This represents a very sparse distribution of participants in the overall Stage 1 telephone survey sample and precluded developing proportional samples, as was done in Vaughan and Russell (1982), since these samples would have eliminated some scarce positive observations. The problem was compounded by the fact that in the telephone survey respondents were asked only whether or not they had fished and not about the type of fishing that they did. Information about Great Lakes/saltwater fishing had to be drawn from the mail survey data, which was already a much smaller sample than the telephone survey. As will be shown in more detail below, these problems were addressed in two ways. Since nothing could be done about sample proportions that were unbalanced by state, the models must implicitly assume that the coefficients in the estimated equations do not vary across states-i.e., that there is no inherent difference between a representative individual in state i and one in state j , $i \neq j$. If the survey data did not have the sparse distribution of "participants" noted above, this assumption could be tested empirically, but unfortunately that is not possible in the present case.

As with the freshwater fishing study, our sample is also unbalanced with respect to Standard Metropolitan Statistical Area (SMSA) residence. In the U.S. as a whole, about two-thirds of the population resides in metropolitan counties (SMSA's) while one-third resides in non-SMSA counties. In our samples, these proportions are generally reversed, so that we have "too few" SMSA residents and "too many" non-SMSA residents. This will bias the regression results if SMSA residents are systematically different from non-SMSA residents in their fishing behavior. In order to

account for this, we interacted a metro/non-metro dummy variable with each of the other independent variables in the models.

The remainder of this chapter discusses in greater detail the construction of datasets used for estimation, including participation survey and water availability data; and some special problems with our availability measures, as they relate to estimating benefits of recreational fishing due to improved water quality.

Survey Data for Probability of Participation

The database used to estimate the probability of participation models is derived from three sources: the availability data described in a later section, the telephone survey dataset and the mail survey dataset. Since data on participation in Great Lakes/saltwater fishing could only be derived from the mail survey, the number of usable observations in the mail survey imposed the upper limit on the total number of respondents that could be used in the probability models. The telephone survey contained 243,513 usable records with complete data on whether or not an individual did any fishing (of unknown type), and socio-economic data on county of residence, income, and age and sex of the respondent. The mail survey, on the other hand, contained 9361 usable observations on individuals who did some type of fishing, including details on the number of days they spent fishing in the Great Lakes, along saltwater coasts, and off-shore (beyond the three mile limit). Note that the 9361 usable records include both freshwater (excluding Great Lakes) and Great Lakes/saltwater fishermen.

Since we had no precise estimate of the expected frequencies of Great Lakes and saltwater fishing in the large telephone survey sample, we decided to “balance” our probability estimation sample by the following

method. We first calculated the state-level probabilities that a respondent in the 243,513 sample would admit to doing some fishing. Next, we created a subsample of nonfisherman as identified in the large telephone survey sample. We then calculated the number of respondents by state in the mail survey sample of 9361 fisherman observations, and, using the expected probability derived from the telephone survey, calculated (again, by state) the number of non-fishing individuals required to create a database using all the fishermen in the mail survey, and displaying the same relative frequency of fishermen to non-fishermen found in the 243,513 observation telephone survey dataset. The required number of non-fishermen were then drawn randomly by state from the sample of non-fishermen, resulting in a sample (for probability estimation) of 28,584 individuals.

The 28,584 sample contained approximately 600 individuals per state, and within each state contained the same ratio of fishermen to non-fishermen found in the large telephone survey--hence the "balanced" nature of the sample for probability estimation. Variable definitions and sample means and standard deviations are shown in table 5.1. Note that this sample reflects the same metro/non-metro and state-by-state imbalances as the original telephone survey.

Survey Data for Intensity Models

Six datasets were used for estimating the intensity of participation, given that an individual does "some of" a particular activity. The three fishing types--Great Lakes (GTLA), inshore saltwater (INSH or SALT), and offshore saltwater (DEEP) (beyond the three mile limit) -- were taken directly from the probability of participation dataset. The criterion for "pulling" an observation was simply whether or not an individual had a

Table 5.1. Data for Probability Estimation:
Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
GLFISH	0.0121	0.1096
INSHFISH	0.0745	0.2627
DEEPFISH	0.0285	0.1666
METRO	0.4153	0.4927
LNAGE	3.224	0.877
METLNAGE	1.328	1.673
LNINC	9.249	0.957
METLNINC	3.897	4.660
SEX	0.4458	0.4970
GLDIST	733.	511.
GLDISTM	337.	531.
INSHDIST	319.	312.
INSHDISM	108.	224
DEEPDIST	319.	312.
DEEPDISM	108.	224.
STFWACRE	0.0202	0.0127
STFWACRM	0.0085	0.0131
STFWDIST	8.555	3.970
STFWDISM	3.484	4.721
HDD	5319.	1886.
HDDM	2095.	2752.

Number of observations: 28,584

Variable Definitions

Notes to Table 5.1 (applicable also to Tables 5.2 through 5.7)

<u>Variable</u>	<u>Definition + source.</u>
GLFISH	1 if respondent did some Great Lakes Fishing, 0 otherwise. From combined telephone/mail surveys.
INSHFISH	1 if respondent did some inshore saltwater fishing, 0 otherwise. From combined telephone/mail surveys.
DEEPFISH	1 if respondent did some offshore saltwater fishing, 0 otherwise. From combined telephone/mail surveys.
METRO	1 if respondent resides in an SMSA county, 0 otherwise. From combined surveys.
LNAGE	Natural log of respondent's age. Age taken directly from combined surveys, then transformed.
METLNAGE	METRO*LNAGE.
LNINC	Natural log of respondent's income (1975 dollars). Income taken directly from combined surveys, then transformed.
METLNINC	METRO*LNINC
SEX	1 if female, 0 if male. From combined surveys.
METSEX	METRO*SEX
GLDIST	Distance from population centroid of respondent's home county to the nearest Great Lakes coast, corrected for pollution and reasons other than pollution, pre-policy. See text for further explanation.
GLDISTM	METRO*GLDIST
INSHDIST	Distance to nearest inshore saltwater, pre-policy.
INSHDISM	INSHDIST*METRO
DEEPDIST	Distance to nearest offshore saltwater, pre-policy.
DEEPDISM	DEEPDIST*METRO
STFWACRE	State freshwater availability, (Acres freshwater * fraction unpolluted)/(Total state surface area, pre-policy. See appendices 5.B, 5.C, 5.D.
STFWACRM	STFWACRE*METRO

Notes to Table 5.1 (continued)

STFWDIST	$(\text{STFWACRE})^{-0.5}$ See chapter 2 and appendix 5.B.
STFWDISM	STFWDIST*METRO
HDD	Heating degree days, see appendix 5.D.
HDDM	HDD*METRO
GTLADA	Number of days respondent did some Great Lakes fishing. From mail survey.
LNGTLADA	Natural log of GTLADA.
PREF	1 if individual prefers fishing to other outdoor wildlife-related activities, 0 otherwise.
METPREF	METRO*PREF
SALTDA	Number of days respondent did some inshore saltwater fishing. From mail survey.
LNSALTDA	Natural log of SALTDA.
DEEPDA	Number of days respondent did some offshore saltwater fishing (beyond the three-mile limit). From mail survey.
LNDEEPDA	Natural log of DEEPDA

value greater than zero for the appropriate “days” variable, GTLADA, SALTDA, and DEEPDA. From these positive days subsets (“ALL OBS”) we then created three additional subsets, consisting of only those individuals residing within 250 miles of the respective coast--GLDIST ≤ 250 for the Great Lakes participants, and INSHDIST ≤ 250 for the inshore saltwater and offshore saltwater participants. Sample statistics for the resulting six groups are shown in tables 5.2 through 5.7.

Water Availability Data

The development of the availability data is described in appendix 5.3 of this report. Great Lakes and saltwater fishing availabilities from the Dyson report (Appendix 5.C) were used, where appropriate, and freshwater fishing availability data was taken from the RFF Survey of Fishable Water (See Vaughan and Russell (1982), chapter 2, for a complete discussion of the methodology of the earlier survey). For the six states where no responses were received on the freshwater fishing availability, We regressed the RFF survey responses on the RFF Water Quality Network model results, and used the predicted values thus obtained to "fill in" the six missing values. One other "fix" for the data was required. Since Indiana did not report Great Lakes fishing restrictions prior to implementation of the Clean Water Act, we substituted the corresponding values from Illinois, since its Great Lakes coastline (on Lake Michigan) is contiguous with that for Indiana. Definitions of the individual variables, with their national means, are shown in table 5.8.

Table 5.2. Great Lakes Intensity of Participation Estimation:
 All Individuals Doing Some Great Lakes Fishing
 Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
GTLADA	11.11	16.88
LNRTLADA	1.734	1.146
METRO	0.5603	0.4970
LNAGE	3.489	0.447
METLNAGE	1.941	1.752
LNINC	9.2146	1.207
METLNINC	5.222	4.713
SEX	0.066	0.249
METSEX	0.037	0.190
GLDIST	181.8	366.8
GLDISTM	99.6	304.7
INSHDIST	508.1	236.2
INSHDISM	279.7	299.1
DEEPLDIST	508.1	236.3
DEEPLDISM	279.7	299.1
STFWACRE	0.0221	0.0122
STFWACRM	0.0118	0.0141
STFWDIST	7.799	2.959
STFWDISM	4.514	4.616
HDD	6554.9	1459.3
HDDM	3603.5	3372.4
PREF	0.5000	0.5007
METPREF	0.3333	0.4720
Number of observations:	348	

Table 5.3. Great Lakes Intensity of Participation Estimation:
Includes Only Individuals Within 250 Miles of the Great Lakes
Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
GTLADA	10.57	16.20
LNGTLADA	1.693	1.1394
METRO	0.570	0.496
LNAGE	3.473	0.440
METLNAGE	1.972	1.750
LNINC	9.241	1.18
METLNINC	5.322	4.71
SEX	0.072	0.259
METSEX	0.045	0.207
GLDIST	43.1	56.6
GLDISTM	20.0	40.3
INSHDIST	542.1	197.6
INSHDISM	306.2	301.0
DEEPDIST	542.1	197.6
DEEPDISM	306.2	301.0
STFWACRE	0.0227	0.0118
STFWACRM	0.0126	0.0144
STFWDIST	7.603	2.86
STFWDISM	4.439	4.45
HDD	6877.3	1000.6
HDDM	3861.7	3440.7
PREF	0.546	0.499
METPREF	0.371	0.484
Number of Observations:	291	

Table 5.4. Inshore Saltwater Intensity of Participation
 Estimation: All Individuals Doing Some Inshore Saltwater Fishing
 Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
SALTDA	12.82	20.28
LNSALTDA	1.819	1.1860
METRO	0.488	0.500
LNAGE	3.485	0.442
METLNAGE	1.697	1.765
LNINC	9.304	1.142
METLNINC	4.572	4.754
SEX	0.148	0.355
METSEX	0.0722	0.259
GLDIST	972.8	494.1
GLDISTM	506.2	611.4
INSHDIST	82.8	177.5
INSHDISM	33.2	114.1
DEEPDIST	82.7	177.5
DEEPDISM	33.2	114.0
STFWACRE	0.025	0.013
STFWACRM	0.012	0.016
STFWDIST	7.205	2.901
STFWDISM	3.496	4.0350
HDD	4687.7	1860.3
HDDM	2150.9	2545.7
PREF	0.593	0.491
METPREF	0.319	0.466

Number of observations: 2,132

Table 5.5. Inshore Saltwater Intensity of Participation
 Estimation: Includes Only Individuals Within 250 Miles
 of Saltwater Coast
 Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
SALTDA	13.66	21.14
LNSALTDA	1.885	1.195
METRO	0.494	0.500
LNAGE	3.488	0.4406
METLNAGE	1.718	1.764
LNINC	9.321	1.12
METLNINC	4.63	4.76
SEX	0.146	0.353
METSEX	0.072	0.259
GLDIST	1016.39	477.3
GLDISTM	539.4	621.9
INSHDIST	29.9	55.6
INSHDISM	11.8	37.8
DEEPDIST	29.8	55.6
DEEPDISM	11.8	37.7
STFWACRE	0.0262	0.01326
STFWACRM	0.0132	0.01675
STFWDIST	6.968	2.738
STFWDISM	3.412	3.823
HDD	4563.1	1846.2
HDDM	2122.6	2496.8
PREF	0.598	0.490
METPREF	0.320	0.467

Number of observations: 1,908

Table 5.6. Offshore Saltwater Intensity of Participation
 Estimation: All Individuals Doing Some Offshore Saltwater Fishing
 Wans and Standard Deviations of Variables

Variable	Mean	Standard Deviation
DEEPDA	5.711	13.20
INDEEPDA	0.9890	1.044
METRO	0.5201	0.500
LNAGE	3.493	0.414
METLNAGE	1.815	7.770
LNINC	9.366	1.124
METLNINC	4.876	4.757
SEX	0.107	0.310
METSEX	0.0526	0.223
GLDIST	911.7	502.8
GLDISTM	518.5	610.2
INSHDIST	103.4	192.4
INSHDISM	45.3	133.7
DEEPDIST	103.3	192.4
DEEPDISM	45.2	133.7
STFWACRE	0.0255	0.0142
STFWACRM	0.0132	0.0168
STFWDIST	7.20	2.80
STFWDISM	3.79	4.09
HDD	4493.0	1987.0
HDDM	2158.6	2502.4
PREF	0.588	0.492
METPREF	0.3439	0.475

Number of observations: 817

Table 5.7. Offshore Saltwater Intensity of Participation
 Estimation: Includes Only Individuals Within 250 Miles of Saltwater Coast
 Means and Standard Deviations of Variables

Variable	Mean	Standard Deviation
DEEPDA	6.25	14.1
LNDEEPDA	1.07	1.067
METRO	0.529	0.500
LNAGE	3.49	0.410
METLNAGE	1.85	1.77
LNINC	9.38	1.09
METLNINC	5.00	4.77
SEX	0.104	0.306
METSEX	0.0528	0.224
GLDIST	978.0	80.0
GLDISTM	576.3	624.7
INSHDIST	36.1	60.0
INSHDISM	14.4	42.1
DEEPDIST	36.0	60.0
DEEPDISM	14.3	2.0
STFWACRE	0.027	0.0143
STFWACRM	0.014	0.0175
STFWDIST	6.91	2.61
STFWDISM	3.72	3.881
HDD	4331.	1977.0
HDDM	2083.	2400.
PREF	0.586	0.493
METPREF	0.344	0.475
Number of observations:	701	

Table 5.8. Availability Dataset (Prior to Merge With Participation)

Variable	Mean	Standard Deviation
GLDIST	629.6	449.4
GLDISTPO	536.1	383.1
INSHDIST	394.7	302.6
INSHDIPO	394.6	302.6
DEEPDIST	394.5	302.7
DEEPDIPO	394.5	302.7
COFWACRE	0.0199	0.02910
COFWACPO	0.0214	0.0308
COFWDIST	13.8	18.4
COFWDIPO	13.1	17.9
STFWACRE	0.0196	0.0124
STFWACPO	0.0211	0.0135
STFWDIST	8.30	3.28
STFWDIPO	7.84	2.35

Notes to Table 5.8

<u>Variable Name</u>	<u>Definition</u>
GLDIST	Distance (in miles) to nearest Great Lakes coastline, corrected for unavailability due to pollution and reasons other than pollution (inaccessable shoreline, etc.)
GLDISTPO	Distance (in miles) to nearest Great Lakes coastline, post-policy. Assumes full implementation of BAT, BCT, and BMP and that non-pollution restrictions still apply
INSHDIST	Distance (in miles) to nearest inshore saltwater coastline, corrected for unavailability due to pollution and reasons other than pollution

Notes to Table 5.8 (Continued)

INSHDIPO	Distance (in miles) to nearest inshore saltwater coastline, post-policy. Assumes full implementation of BAT, BCT, and BMP and that non-pollution restrictions still apply
DEEPDIST	Distance (in miles) to nearest offshore saltwater, pre-policy. Analogous to INSHDIST, above
DEEPIPO	Distance (in miles) to nearest offshore saltwater, post-policy. Analogous to INSHDIPO, above
COFWACRE	County level (acres freshwater)/(acres total area), multiplied by the fraction unpolluted, pre-policy. See appendices 5.B. and 5.C.
COFWDIPO	County level (acres freshwater)/(acres total surface area). Assumes no pollution restrictions on freshwater fishing, post-policy. See appendices 5-B and 5-C.
COFWDIST	$(COFWACRE)^{-0.5}$. (See chapter 2 and appendix 5.B).
COFWDIPO	$(COFWACPO)^{-0.5}$. (See chapter 2 and appendix 5.B).
STWFACRE	state-level analog of COFWACRE
STFWACPO	state-level analog of COFWACPO
STFWDIST	$(STFWACRE)^{-0.5}$. (See chapter 2 and appendix 5.B).
STFWDIPO	$(STFWACPO)^{-0.5}$. (See chapter 2 and appendix 5.B).

Problems with the Data on Pollution and Availability

The Dyson survey was done because there exists no comprehensive national database of water quality parameters that would allow us to characterize base period availability of water for particular activities and to determine the extent of changes in water quality attributable to implementation of the Clean Water Act. The survey consisted of a questionnaire sent to state officials who could be assumed knowledgeable about base period water quality and changes in quality that have occurred over the past decade in their states. One very important point is that officials were asked the relevant questions only at the state level. Data for finer levels of geographic aggregation were not solicited, because it was believed that the respondents' ability to recall more detailed information would be limited and that the reaction to such questions might well be refusal to respond at all. While this was a reasonable approach given the lack of environmental quality data from actual monitoring programs, it made it necessary to impose a fairly strong assumption on the data used in estimating the participation models: namely, that changes in water quality following implementation of the Clean Water Act would be uniformly distributed across the state's water bodies. This can have serious consequences for the generation of the data used in the econometric models, due to the methods we had to use for generating our distance-to-coast variables (GLDIST, INSHDIST, and DEEPDIST). In particular, for coastlines that were seriously polluted pre-policy, we have probably systematically overstated the change in the distance-to-coast variables, due to policy implementation.

To see why this is so, consider two hypothetical individual survey respondents, R_1 and R_2 . For both respondents, their closest Great Lakes

coastline is in a state where the pre-policy fishing availability is limited, and in this hypothetical state, 50 percent of the Great Lakes water is too polluted for fishing. Assume further that the straight-line "raw" distance (before pollution "corrections") for R_1 is 100 miles, while for R_2 it is 10 miles, and that no water is unavailable for reasons other than pollution. Using the methods outlined in appendix 5.D, the pre-policy distances for the two individuals are:

$$DPRE_1 = \frac{100 \text{ miles}}{0.5} = 200 \text{ miles}$$

$$DPRE_2 = \frac{10 \text{ miles}}{0.5} = 20 \text{ miles}$$

The post-policy distances (when 100 percent of the water is fishable) are:

$$DPOST_1 = \frac{100 \text{ miles}}{1.0} = 100 \text{ miles}$$

$$DPOST_2 = \frac{10 \text{ miles}}{1.0} = 10 \text{ miles.}$$

This is likely to overstate the reduction in distance that R_1 would have to travel, attributable to policy implementation, if in fact pollution is not evenly distributed along coastlines and across water bodies, since in the pre-policy situation there would probably be badly polluted segments (adjacent to major cities, for example), interspersed with relatively clean segments, away from major industrial areas.

If we had been able to obtain point-by-point water quality data for the coastlines and time periods of interest, the above problem would not have arisen. Even if the data were available at a relatively aggregated level -- for example, by county -- we could have simply eliminated some counties as potential destinations for fishermen, and re-calculated the "closest" points for each survey respondent without considering the

"polluted" counties. Other, similar approaches could have been used depending on the type of water quality data available from a monitoring effort.

Since there were insufficient water quality monitoring data available, one possibility would have been to use the output from a water quality model, such as that developed by Peskin and Gianessi (See Vaughan, et. al. 1982 for a description). However, this model's geographic coverage is not complete for the coastal areas of interest to us, and it does not include the necessary parameters of water quality to determine with reasonable certainty whether or not a particular water body is indeed fishable. We had, therefore, no alternative but to use the Dyson survey results and to live with the problems outlined above.

The problem of the overstatement of the change in expected travel distance is especially severe for the Great Lakes. As can be seen from table 5.8, the average (over all counties) of the distance to the Great Lakes decreases from 629.6 miles pre-policy to 536.1 miles post-policy, a decrease of about 15 percent, while corresponding changes for INSHDIST, STFWDIST, and COFWDIST range from less than 1 percent to about 5 percent. While it may be true that the Great Lakes were more polluted in the mid-70's than were other water bodies in the U.S., it seems unlikely that individuals would have needed to travel almost 100 miles more than their uncorrected straight-line distance just to find fishable water there.

Clearly, the long-term answer to these problems is an adequate water quality monitoring program, since evaluating the benefits of cleaner water is essentially impossible without comprehensive data on base-line and post-policy environmental conditions. As will be seen in chapters 6 and 7, the consequences of using data based on the recollections of various

state officials can lead to results that are anomalous and apparently contrary to the implications of economic theory.

APPENDIX 5.A

LOCATING RECREATIONIST'S RESIDENCES

In order to estimate recreation participation equations at the county level, the county of residence of the respondents to a recreation participation survey must be known. In the 1975 NSHFWR, only the state of residence is reported along with the telephone area code and exchange for each survey respondent. The problem, then, is to determine what county each phone number represents.

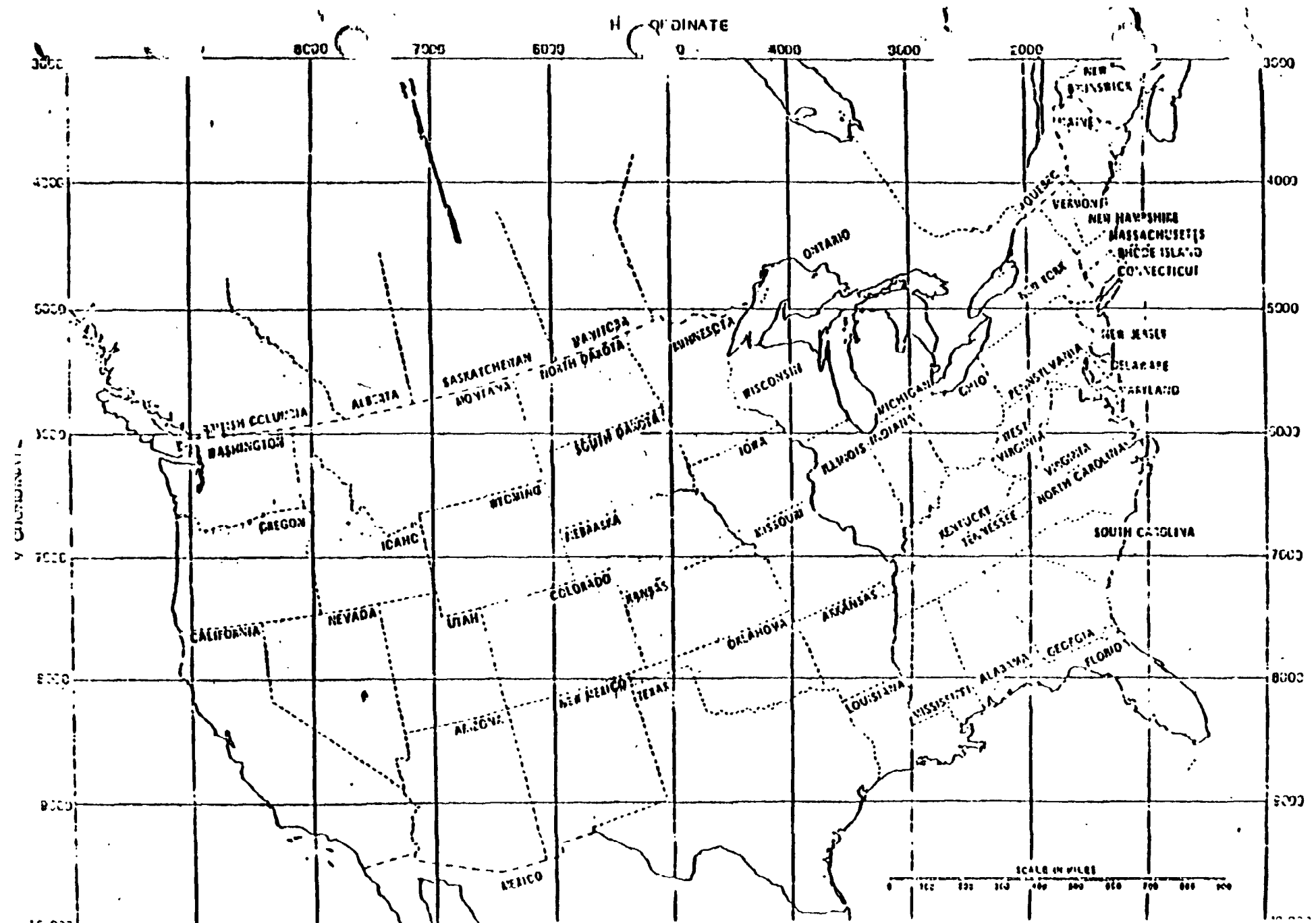
Ideally one would want to have a computerized file of every telephone exchange (the first 3 digits of any 7 digit phone number) for all of the area codes in the country organized by county. With this information, a respondent's county of residence could easily be determined from his telephone number. Since this data is not available it will have to be created from other sources.

The American Telephone and Telegraph (AT&T) Long Lines Company developed a file, for the purpose of calculating the distance traversed by long distance calls, from which we can create the file we need.

AT&T's file contains the state name, place name and vertical (V) and horizontal (H) coordinates for all telephone exchanges in the country. These V and H coordinates are analogous to, but do not correspond with, latitude and longitude coordinates (see the map in figure 5.A.1) and are used by AT&T to calculate the distance between towns. If one could translate the V and H coordinates associated with an individual telephone number into latitude and longitude, the telephone exchange could be assigned to a county by finding the closest geographic county centroid to that latitude and longitude. Individuals could then be assigned to the county of their telephone exchange.

Figure 5.A.1

V and H Coordinate Map



Unfortunately it was impossible to determine from AT&T how the V and H coordinate system was developed or what analytical functional relationship exists between latitude and longitude and the AT&T coordinate system. Therefore, statistical methods were necessary in order to develop an empirical relationship between latitude, longitude and V and H.

ESTIMATION OF FUNCTIONS TO CONVERT V AND H TO LATITUDE AND LONGITUDE

Known latitudes and longitudes from a random sample of 205 specific places in the United States were regressed on corresponding V and H coordinates to fit a function which could convert V and H to latitude and longitude. The latitude and longitude coordinates for 205 American towns were taken from the London Times World Atlas and these towns were located in the AT&T file for their corresponding V and H coordinates. The independent variables latitude and longitude were converted to decimal equivalents from the degree-minute-second units reported in the atlas.

Both latitude and longitude obtained from the Atlas were regressed separately against V and H. The general form of the second order equation fitted for both latitude and longitude is:

Lat (or Long) =

$$b_0 + b_1V + b_2H + b_3V^2 + b_4H^2 + b_5VH + e$$

This function is referred to as Model 1. The terms b_0 through b_5 are the equation parameters. The independent variables are V, H, V^2 , H^2 and VH. Two squared terms are included since latitude and longitude define a spherical coordinate system. The e's are independent, identically normally distributed error terms with mean zero and constant variance. The latitude regression results appear in tables 5.A.1 and 5.A.2. The overall relationship is highly significant, as are each of the parameter estimates,

Table 5.A.1
Analysis of Variance Table for Latitude, Model I

Source	Degrees of Freedom	Sum of Squares	Mean Square
Regression	5	4307.695	861.539
Residual	199	1.211626	0.006089
Corrected Total	204	4308.906	
Root Mean Square Error: 0.0708029			
$R^2 = 0.9997$			
F value: 141,500.9 significant at 0.0001			

Table 5.A.2

Parameter Estimates for Latitude, Model I

Variable	Parameter Estimate	t for H_0 Parameter = 0	Prob > t
Intercept	53.121753	344.542	0.0001
V	-0.00307006	-56.585	0.0001
H	0.003675643	148.324	0.0001
V^2	-5.02973E-08	-10.822	0.0001
H^2	-1.392063-07	-110.894	0.0001
VH	-9.84146E-08	-27.402	0.0001

despite the potential collinearity introduced by the nonlinear terms.

The longitude regression results appear on tables 5.A.3 and 5.A.4. Again, the overall relationship is highly significant, as are all of the parameter estimates.

Table 5.A.3

Analysis of Variance Table for Longitude, Model I

Source	Degrees of Freedom	Sum of Squares	Mean Square
Regression	5	35769.129	7153.826
Residual	199	2.846217	0.014303
Corrected Total	204	35771.975	

Root Mean Square Error: 0.119593

$R^2 = 0.9999$

F value: 500,176.617 significant at .0001

Table 5.A.4
Parameter Estimates for Longitude, Model I

Variable	Parameter Estimate	t for H_0 Parameter = 0	Prob > t
Intercept	43.915199	185.838	0.0001
V	0.005222511	62.804	0.0001
H	0.006138437	161.617	0.0001
V ²	-1.28402E-07	-18.026	0.0001
H ²	1.31851E-07	68.531	0.0001
VH	-2.64590E-07	-48.068	0.0001

Although these estimated relationships appear highly satisfactory, some additional diagnostic analysis of residuals in figures 5.A.2 through 5.A.5 revealed an undesirable pattern suggesting some misspecification of functional form. Ideally the error plots should display a random scatter unless the iid (independent identically distributed) error assumptions have been violated or the functional form has been misspecified.

To investigate this apparent non-random error problem, assuming functional form as the cause, dummy variables were created to tag data points falling outside the band of random scatter on the error plots. All latitudes less than or equal to 34 degrees north, or greater than 44 degrees north, were assigned a dummy variable, DLAT, equal to one. All data points with longitudes greater than 106°W were assigned a dummy variable, DLONG, equal to one. If the data points were between 34° and 44° degrees latitude and less than 106°W longitude, the dummy variables were set equal to zero. This specification, based on a rather ad-hoc

Figure 5.A.2

Plot of Model I Latitude Residuals Against Latitude

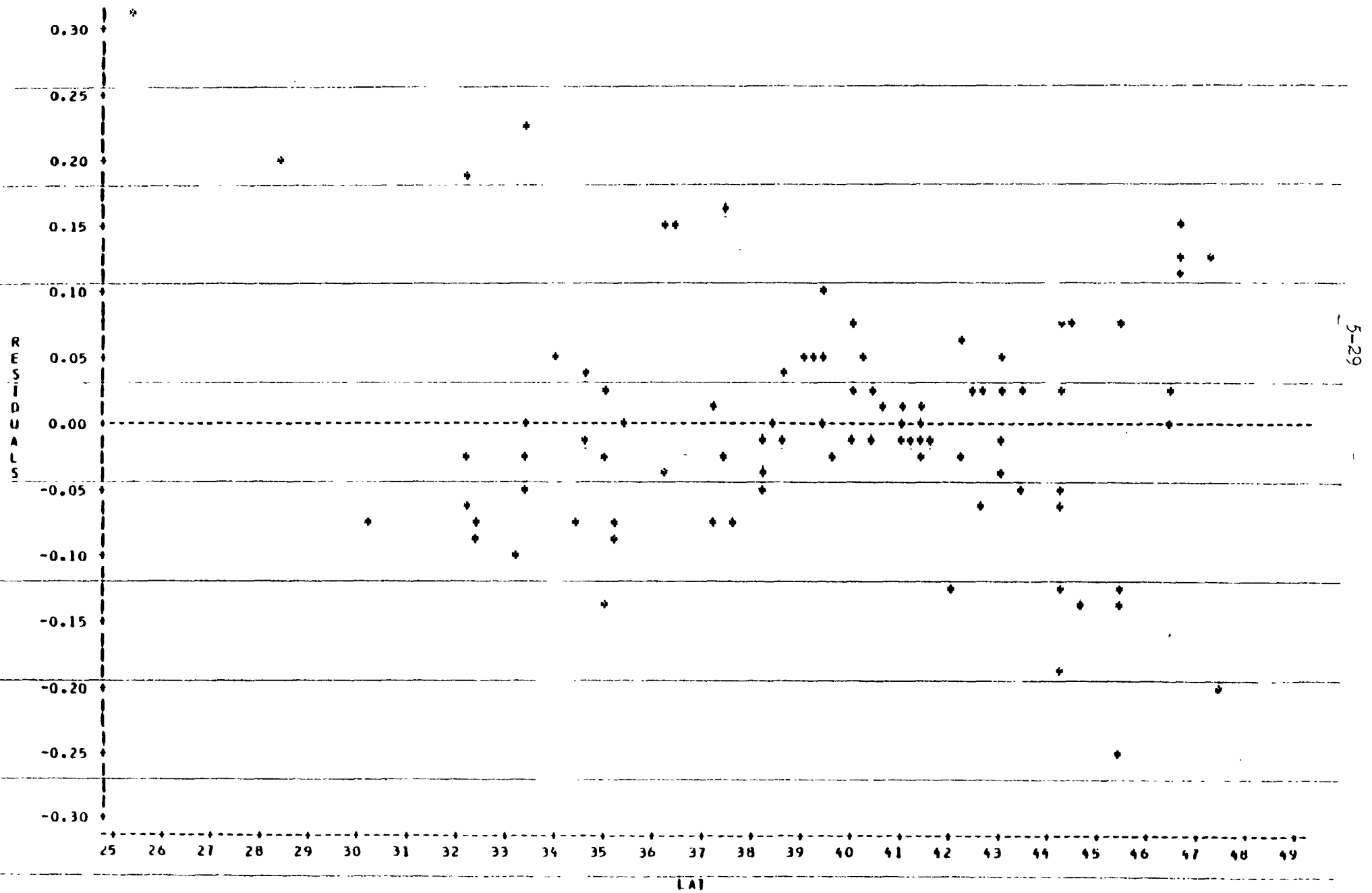
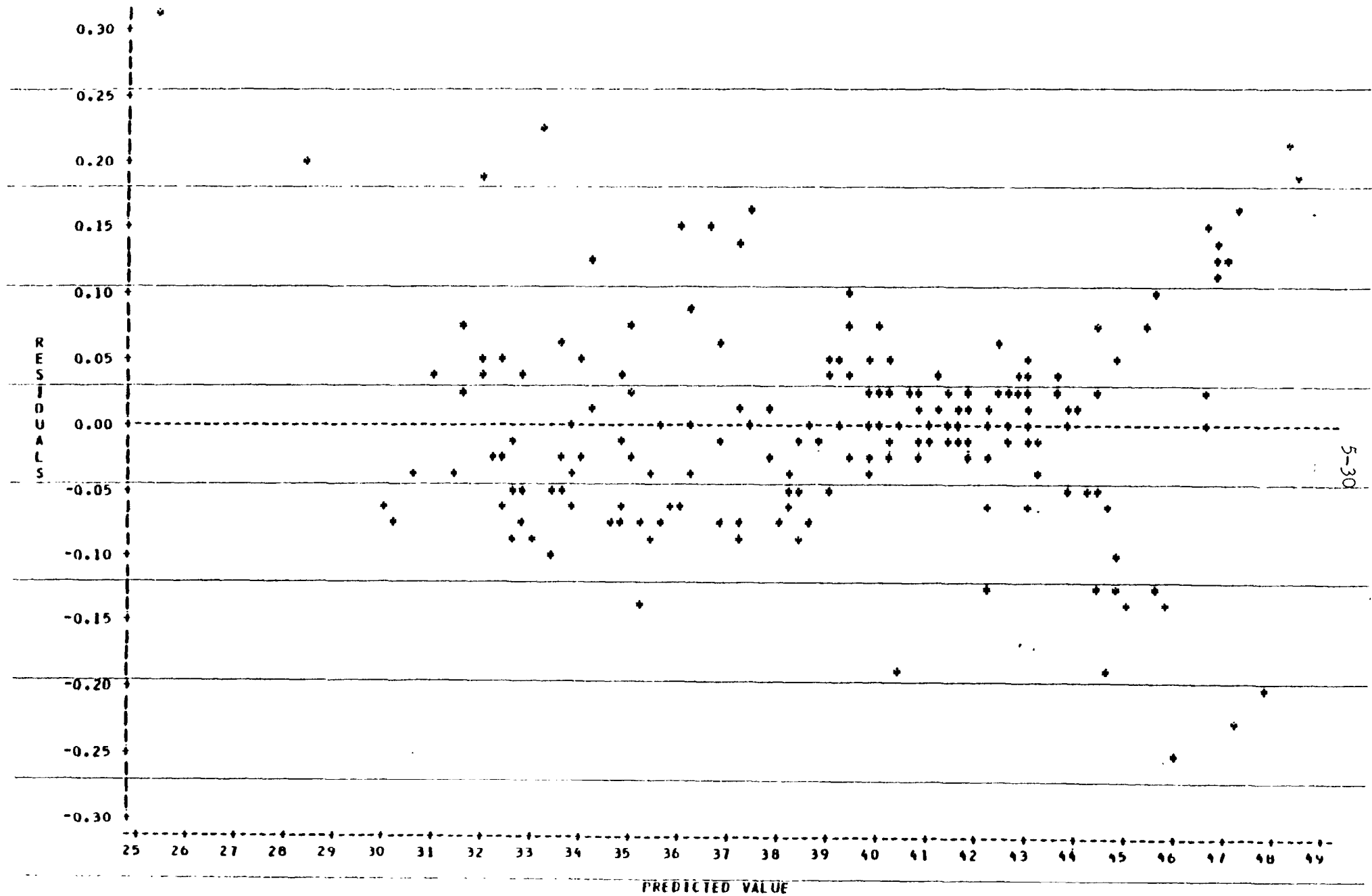


Figure 5.A.3

Plot of Model I Latitude Residuals Against Predicted Latitude



5-30

NOTE: 30 OBS HIDDEN

Figure 5.A.4

Plot of Model I Longitude Residuals Against Longitude

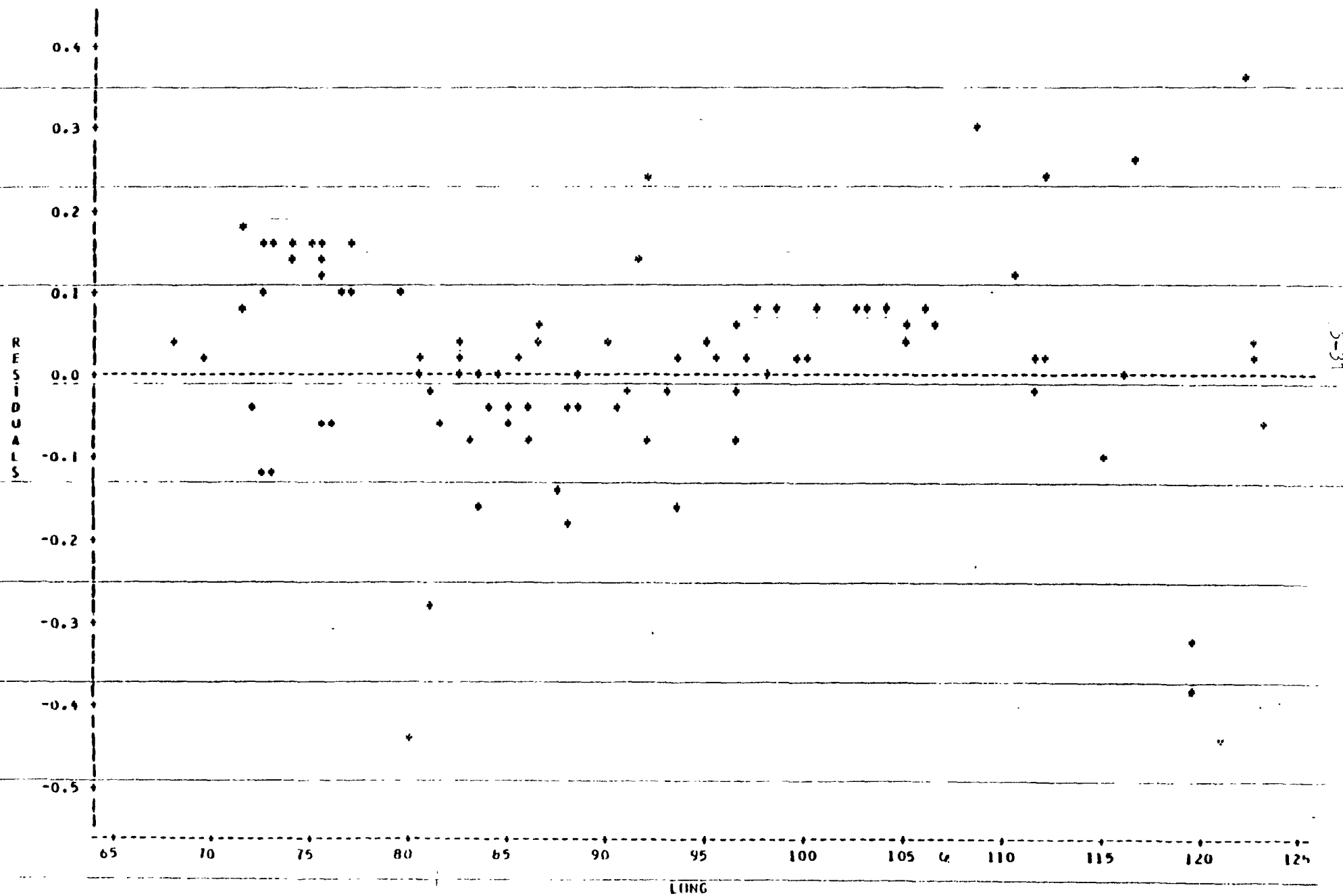
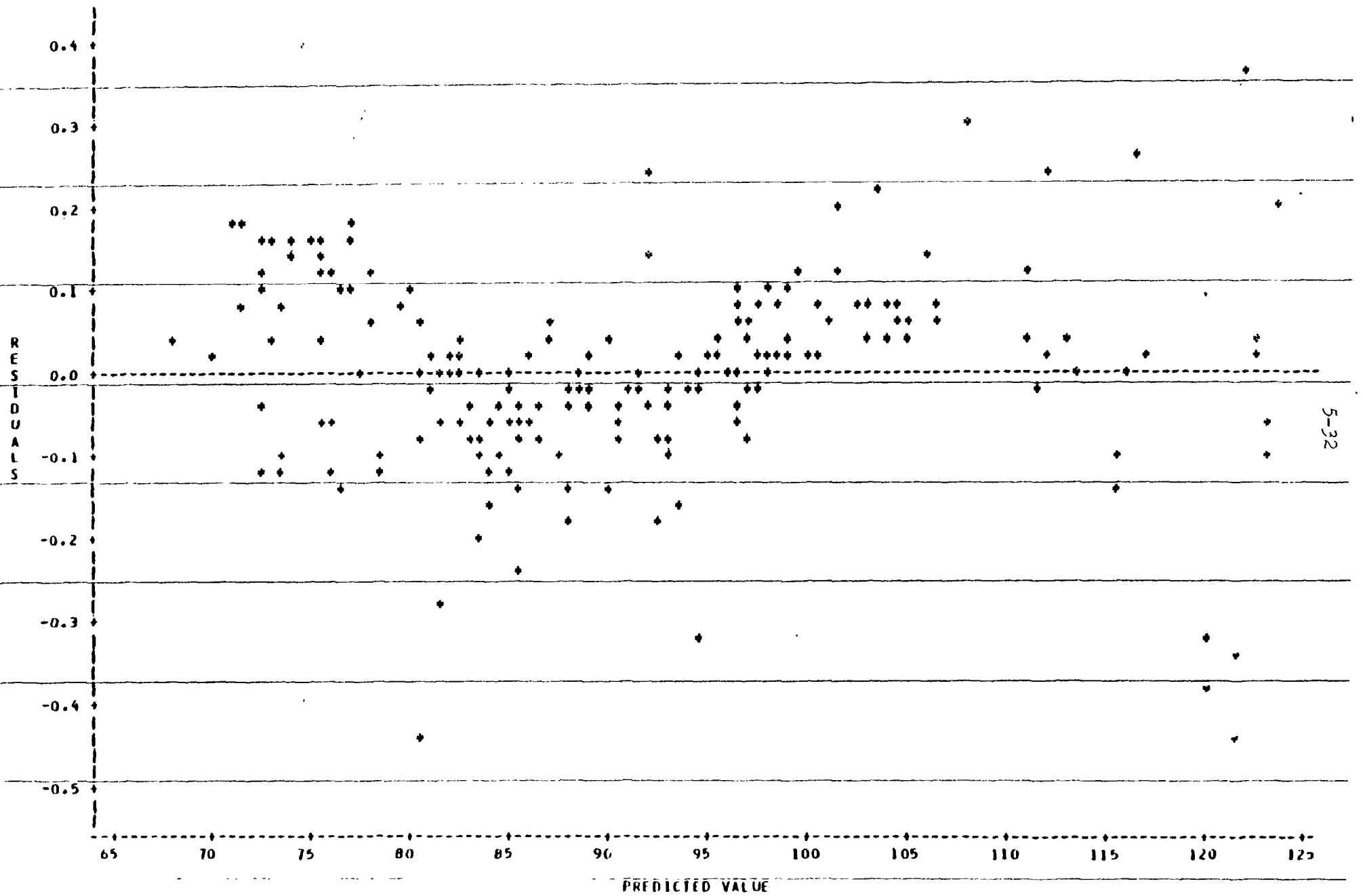


Figure 5.A.5

Plot of Model Longitude Residuals, Against Predicted Longitude



determination of a possible structural break in the Model I specification, results in Model II:

The Model II equations are:

$$\begin{aligned}
 \text{Lat} = & b_0 + b_1 \text{DLAT} + b_2 V + b_3 H + b_4 V^2 \\
 & + b_5 H^2 + b_6 VH + b_7 (\text{DLAT} * V) \\
 & + b_8 (\text{DLAT} * H) + b_9 (\text{DLAT} * V^2) \\
 & + b_{10} (\text{DLAT} * H^2) + b_{11} (\text{DLAT} * VH) \\
 & + e \\
 \text{Long} = & b_0 + b_1 \text{DLONG} + b_2 V + b_3 H + b_4 V^2 \\
 & + b_5 H^2 + b_6 VH + b_7 (\text{DLONG} * V) \\
 & + b_8 (\text{DLONG} * H) + b_9 (\text{DLONG} * V^2) \\
 & + b_{10} (\text{DLONG} * H^2) + b_{11} (\text{DLONG} * VH) \\
 & + e
 \end{aligned}$$

The results of Model II for latitude and longitude appear in tables 5.A.5 through 5.A.8. The new residuals plots for Model II in figures 5.A.6 through 5.A.9 show a more desirable pattern than the Model I residuals.

Table 5.A.5

Analysis of Variance for Latitude Regression
with Dummy Variables

Source	Degrees of Freedom	Sum of Squares	Mean Square
Regression	11	4308.013	391.638
Residual	193	0.893271	0.004628
Corrected Total	204	4308.906	
Root Mean Square Error: 0.068032			
$R^2 = .9998$			
F value: 84,617.157 significant at .0001			

Table 5.A.6

Parameter Estimates for Latitude, Model II

Variable	Parameter Estimate	t for H_0 Parameter = 0	Prob > t
Intercept	52.43119	173.634	0.0001
DLAT	0.687119	1.812	0.0715
V	-0.0027533	-22.942	0.0001
H	0.003491389	60.29	0.0001
V^2	-8.19681E-08	-6.975	0.0001
H^2	-1.37487E-07	-47.754	0.0001
VH	-7.27895E-08	-6.619	0.0001
DLATV	-0.000411574	-2.758	0.0064
DLATH	0.0003655916	5.073	0.0001
DLATV ²	4.36343E-08	3.072	0.0024
DLATH ²	-7.33094E-09	-2.238	0.0263
DLATVH	-4.50912E-08	-3.572	0.0004

Table 5.A.7

Analysis of Variance for Longitude Regression
with Dummy Variables

Source	Degrees of Freedom	Sum of Squares	Mean Square
Regression	11	35770.878	3251.898
Residual	193	1.097218	0.00568507
Corrected Total	204	35771.975	

Root Mean Square Error 0.075399

$R^2 = 1.000$

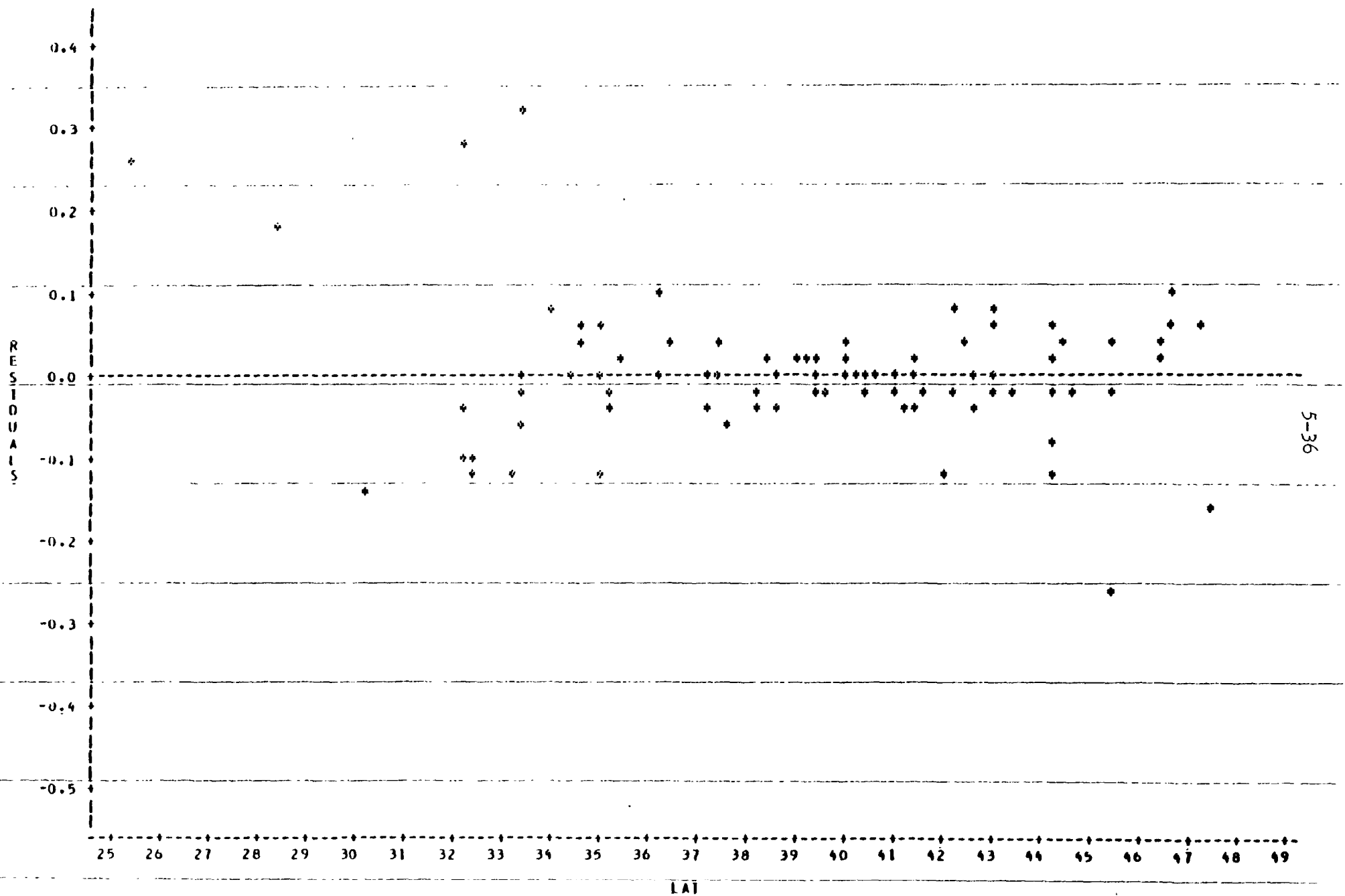
F value: 572,006.696 significant at .001

Table 5.A.8

Parameter Estimates for Longitude, Model II

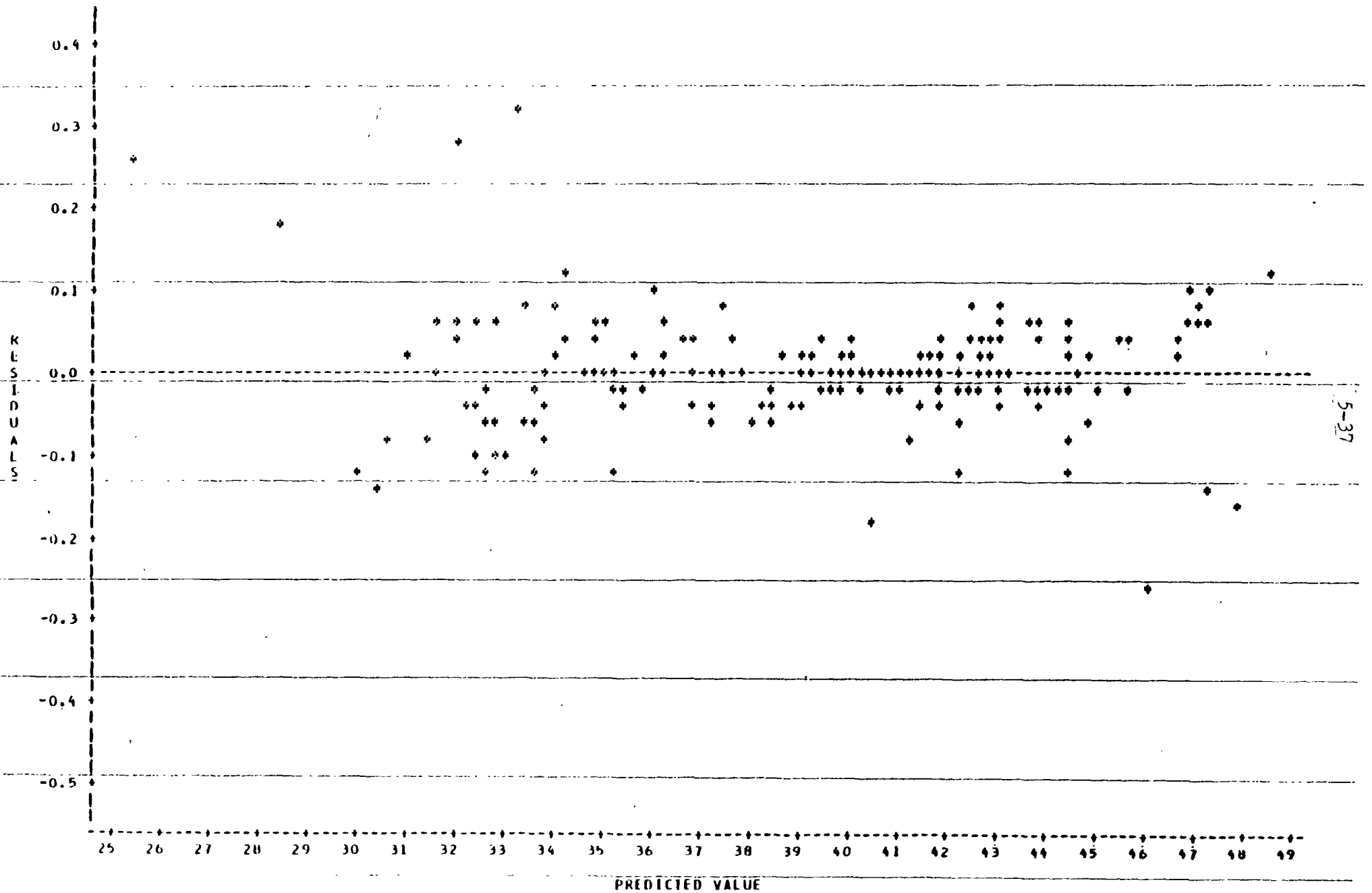
Variable	Parameter Estimate	t for H_0 Parameter = 0	Prob > t
Intercept	43.826864	281.180	.0001
DLONG	-2.403588	-0.765	0.4453
V	0.005409917	97.216	0.0001
H	0.005749532	156.813	0.0001
V^2	-1.51009E-07	-31.439	0.0001
H^2	1.47728E-07	45.314	0.0001
DLONGV	-0.000753896	-1.603	0.1105
DLONGH	0.001926361	4.054	0.0001
DLONGV ²	1.10485E-07	4.724	0.0001
DLONGH ²	-6.09692E-08	-2.789	0.0058
DLONGVH	-1.71129E-07	-6.621	0.0001

Figure 5.A.6
Plot of Model II Latitude Residuals Against Latitude



NOTE: 109 OBS HAD MISSING VALUES 13 OBS HIDDEN

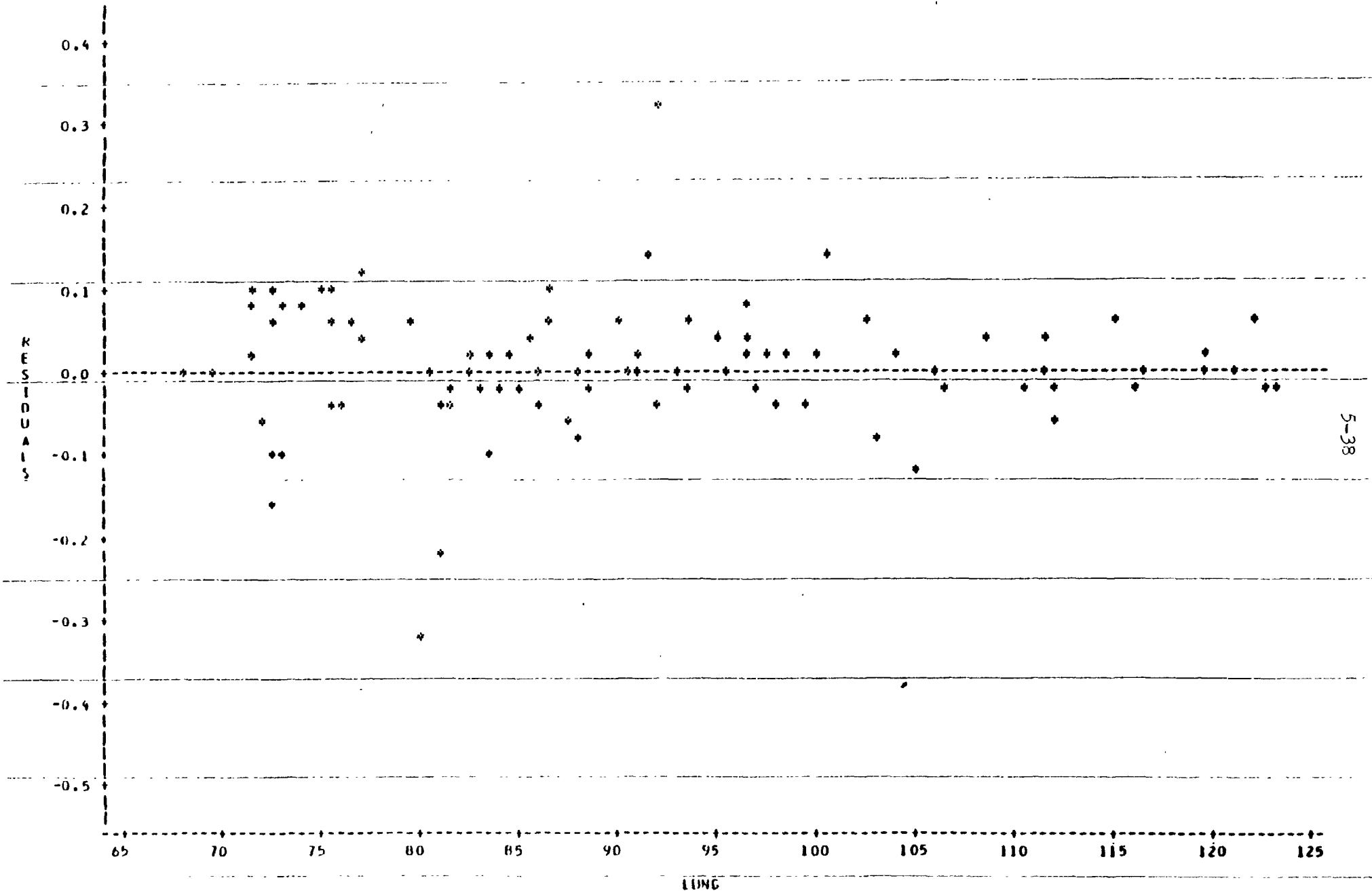
Figure 5.A.7
 Plot of Model II Latitude Residuals Against Predicted Latitude



5-37

Figure 5.A.8

Plot of Model II Longitude Residuals Against Longitude

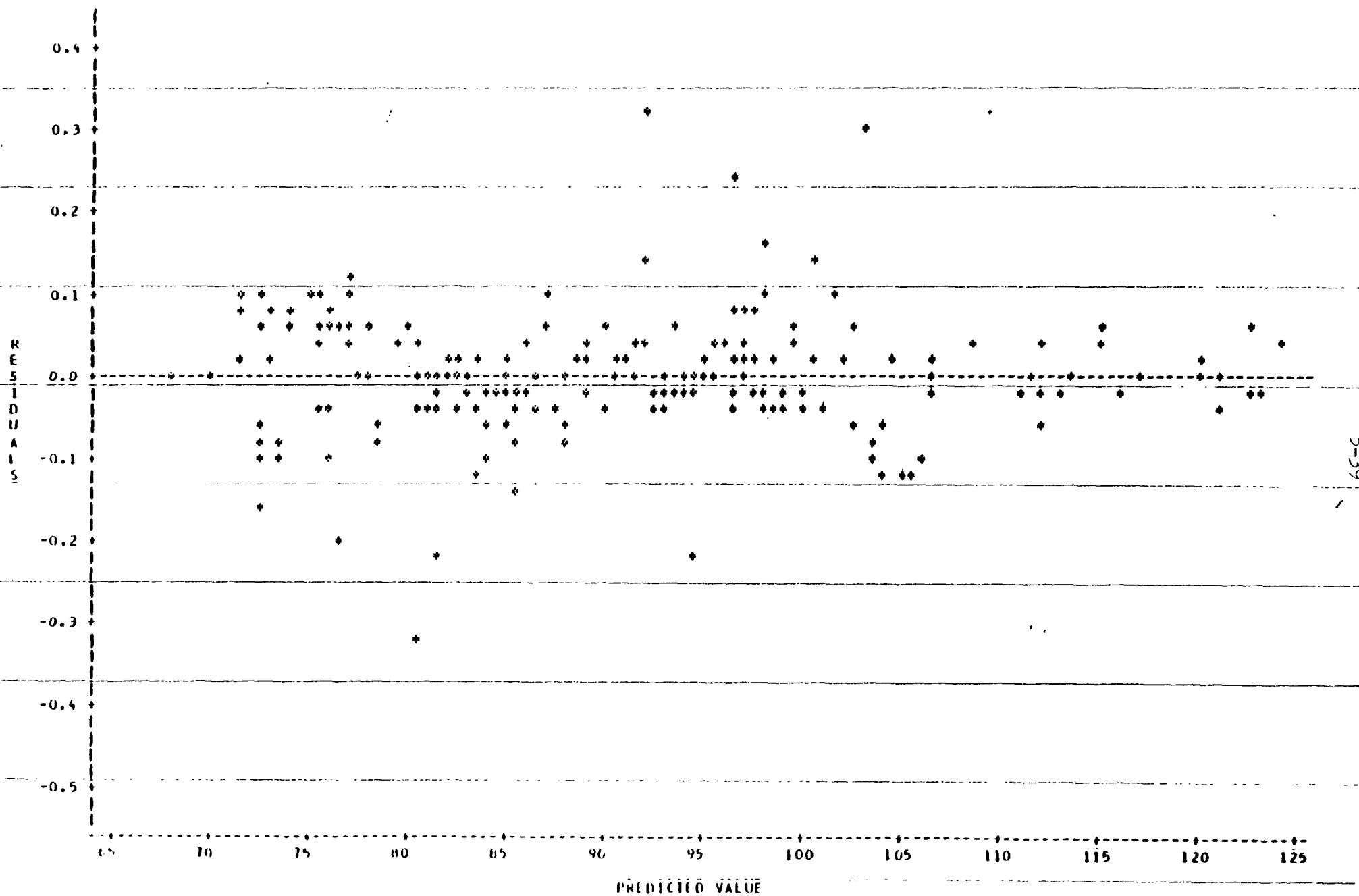


5-38

NOTE: 109 OBS HAD MISSING VALUES 7 OBS HIDDEN

Figure 5.A.9

Plot of Model II Longitude Residuals Against Predicted Longitude



5-39

The null hypothesis of Model I, that there is no structural break, can be tested via a Chow Test (Gujarati, 1970). The test is based on the sums of squared residuals from two separate regressions--one with the dummy variable excluded to impose the restriction of the null hypothesis (SSR_H), and one with the dummy variable included both additively and interactively (SSR_A). The F statistic is computed as:

$$F(m, T-k-m) = \frac{(SSR_H - SSR_A) / m}{SSR_A / (T-k-m)}$$

where

T = number of observations, 205

k = number of variables in the restricted Model I equation, 6

m = number of variables tested with the dummy, 6

The test results indicate that the null hypothesis of Model I can be rejected, so Model II is the preferred specification:

<u>Sums of Squared Residuals</u>			
	<u>Restricted (Model I)</u>	<u>Unrestricted (Model II)</u>	<u>F</u>
Latitude	1.211626	0.893271	11.46*
Longitude	2.846217	1.097218	51.37*

*Significant at the 0.001 level.

A COMPARATIVE EVALUATION OF MODEL PERFORMANCE

In the preceding sections, we have explained the sample data, our choice of functional form, and especially our re-specification of the initial second order polynomial model (Model I) after inspection of the residuals plots, yielding Model II. To give a more intuitive feel for how well we can do in placing any individual at a particular set of latitude and longitude coordinates given the regression conversion

functions and any V and H pair, the following Section will consider prediction error, in percent and distance terms.

Percent Prediction Error

By inspection of the regression results, one can readily discern the high quality of the predictions using either model, without any statistical criterion. However, to show the degree of external validity of the models, we can show how well they perform outside of the sample drawn for estimation, particularly to provide an independent check on the preferred dummy-variable specification of Model II suggested by the data.

To that end, ten cities were drawn at random from those not included in the original sample. The actual (transformed) latitudes and longitudes appear in table 5.A.9, along with the predicted latitudes and longitudes produced by both models. The models can be compared on the basis of a root mean square percent error measure defined as:

$$\text{RMS Percent Error} = (1/N \sum_{i=1}^N ((\hat{Y}_i - Y_i)/Y_i)^2)^{0.5} * 100$$

For Model I, the error is 0.5 percent for latitude and 0.22 percent for longitude, while Model II produces even smaller percent errors of 0.41 for latitude and 0.16 for longitude. Both models are very accurate on average, in terms of percent error.

PREDICTION ERROR IN TERMS OF DISTANCE

To see how badly we might predict in and around the center of our V and H values using Models I and II in terms of distance, crude simultaneous Bonferroni type confidence intervals can be constructed (Miller, 1966). In this case we have a family of statements, one about the expected value of latitude and one about the expected value of longitude, given V and H. The

Table 5.A.9

Predictions for Ten Non-Sample Cities

<u>City</u>	<u>Actual^a Latitude</u>	<u>Predicted Latitude^a</u>		<u>Actual^a Longitude</u>	<u>Predicted Longitude^a</u>	
		<u>Model I</u>	<u>Model II</u>		<u>Model I</u>	<u>Model II</u>
1) Ashtabula, OH.	41.8833	41.8764	41.8571	80.783	80.843	80.826
2) Atlanta, ILL.	40.2667	40.2849	40.2745	89.250	89.330	89.253
3) Ashby, MN	46.1000	46.0020	46.0378	95.817	95.896	95.790
4) Miami, FLA	25.7500	25.4370	25.4887	80.250	80.626	80.566
5) Orlando, FLA	28.5500	28.3473	28.3756	81.350	81.611	81.565
6) Palo Alto, CA	37.4333	37.2544	37.3798	122.670	122.531	122.170
7) Louisville, KY	38.2167	38.2690	38.2651	85.800	85.815	85.760
8) Albany, NY	42.6667	42.7006	42.6672	73.817	73.629	73.752
9) Bismark, ND	46.8333	46.7067	46.7381	100.800	100.720	100.663
10) Charleston, SC	32.8000	32.6782	32.6510	79.967	79.950	79.974

Note:

a. All measures in translated decimal units, as explained in the text.

probability error rate for the family, $P(F)$, can be chosen as the overall significance level, α . Then the Bonferroni inequality expresses the family confidence level $(1-\alpha)$ in terms of the n individual statement significance levels, α_i , as (Miller, 1966):

$$1 - P(F) \geq 1 - \alpha_1 - \dots - \alpha_n$$

Suppose we want an overall level of confidence of greater than or equal to 99 percent for our prediction of a point and equal statement error rates of 0.01 with two statements, one for latitude and one for longitude. The two-tailed individual critical points of the standard normal (0.005 in each tail) are ± 2.58 . The standard errors of the Model I latitude and longitude regressions are respectively 0.078 and 0.120, while for Model II the same quantities are 0.068 and 0.083, all in degrees. Application of the statement critical points and the conversion of the standard errors of the regressions in degrees of latitude and longitude to equivalent errors in miles¹ (assuming 69 miles per degree latitude and 54 miles per degree longitude) gives the confidence intervals of prediction in miles:²

MODEL I

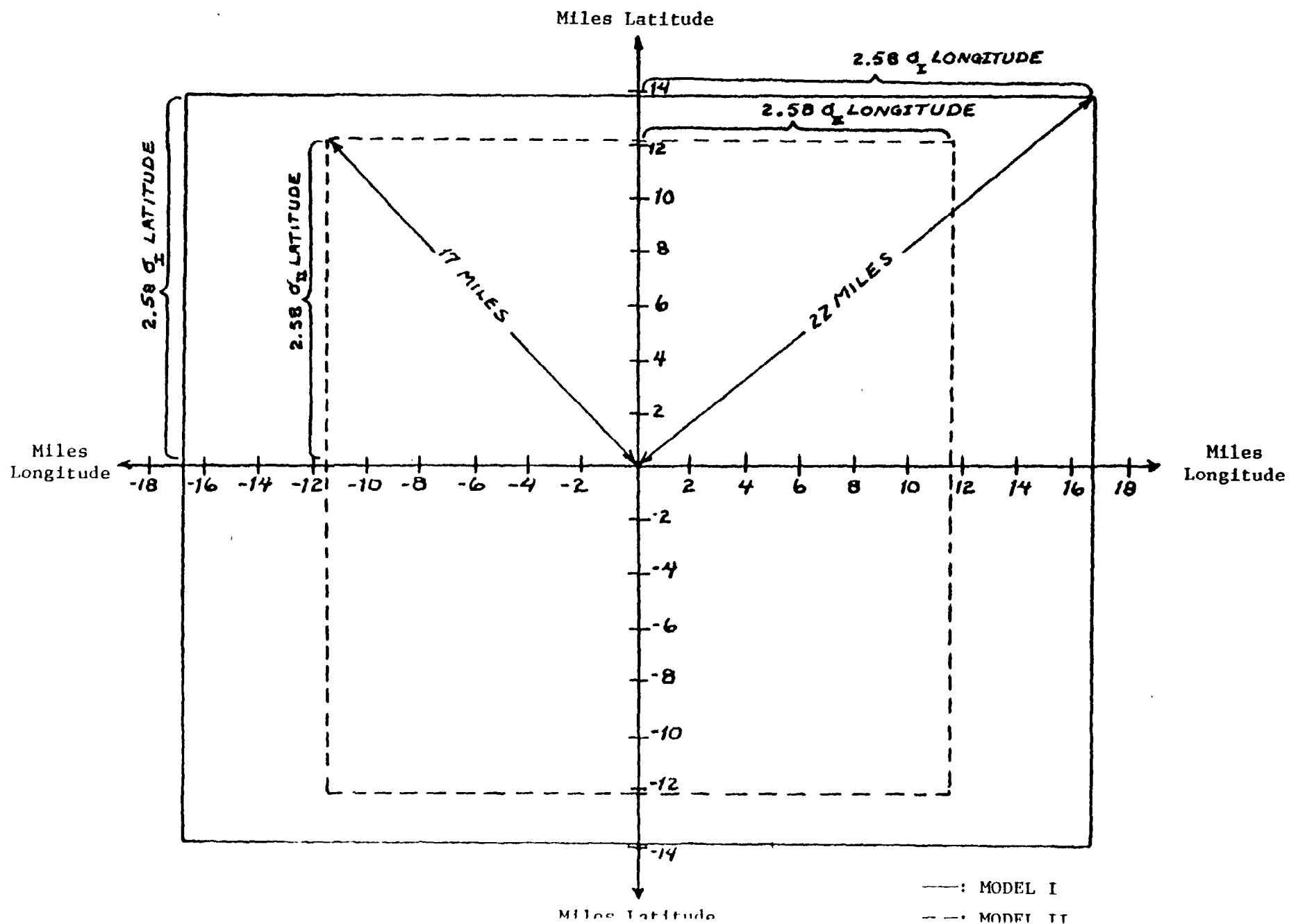
Latitude = $(\pm 2.58) (69) (0.078) = \pm 13.89$ miles
 Longitude = $(\pm 2.58) (54) (0.120) = \pm 16.72$ miles

MODEL II

Latitude = $(\pm 2.58) (69) (0.068) = \pm 12.11$ miles
 Longitude = $(\pm 2.58) (54) (0.083) = \pm 11.56$ miles

The rectangular simultaneous confidence regions based on these intervals are shown in figure 5.A.10, where standard errors in miles indexed by model are noted as σ_I, σ_{II} . The worst we could do in prediction in any particular direction is defined as the length of the diagonal from the center of the region in the figure to any corner, given as the square root of the sums of the squares of the lengths of

Figure 5.A.10. Simultaneous Confidence Intervals for
Prediction of Location at the
99 Percent Level, Models I and II



the sides of the rectangle. For Model I, at the 99 percent level of confidence, we will never be more than 22 miles away from the true location, while for Model II, the prediction error will not exceed 17 miles, treating the parameters of the model as constants, not random variables. So, in a practical sense, Model II puts us five miles closer to the mark, on average, than Model I. Model II will perform adequately for most cities, since the average error (in miles) between the predicted point and the true point in table 5.A.10 for the cities from table 5.A.9 is less than 9 miles, and only one city (Miami) has a distance error which lies beyond our simultaneous confidence bound (which itself technically is only valid at the center of the data):

Table 5.A.10
Model II Prediction Error in Miles
from the True Point

<u>City</u>	<u>Statute Miles per Degree Longitude</u>	<u>Statute Miles in Error</u>
1	52	2.9
2	53	0.6
3	48	4.7
4	62	26.6
5	61	17.8
6	55	3.7
7	55	4.0
8	41	3.3
9	47	9.2
10	58	10.3

In sum, Model II provides a reasonably accurate prediction of any true location, based on the V and H coordinates associated with a particular area code and telephone exchange.

NOTES

1. The true length of one minute of longitude continually decreases from one nautical mile on the equator, to one half mile at 60 degrees North or South latitude, and zero at the poles. Hence, minutes of longitude are only equal to nautical miles at the equator, while minutes of latitude are always equivalent to nautical miles-one minute of latitude equals one nautical mile (Mixter, 1979). Specifically, statute miles per degree longitude equals $\cos \text{Latitude (in Radians)}$ times 69.171.

For example, at Miami a degree of longitude is equivalent to 62 statute miles, while in Bismark it is equivalent to only 47 statute miles. Our illustrative calculations in the text abstract from this problem and evaluate the conversion at the mean of latitude in the sample, 39 degrees north. The distance errors in table 5.A.10, however, are all evaluated at the longitude distance conversion appropriate to the latitude of the given city.

2. The variance of the forecast error consists of two parts. The first is the variance of the disturbance estimated by the standard error of the regression, and the second is the variance of the prediction around its mean (Kmenta, 1971, pp. 240, 375). We ignore the second component in the text, which can be interpreted to mean our forecast confidence intervals pertain to the Center of the V and H data (which converts into 39°N latitude, 91°W longitude) or that we regard the regression parameter estimates as population parameters, not random variables.

APPENDIX 5.B

COMPUTING AVAILABILITY VARIABLES FOR RECREATION MODELS

The availability measures used in the different models of recreational fishing can be conveniently divided into two types: "local" county, or state-level availability measures, and "coastal" availability measures-i.e., distance to the nearest Great Lakes or marine coast. For each type, we start with a "raw" distance measure, and correct that measure for two different factors: water unavailable (prior to implementation of the Clean Water Act) due to pollution, and water unavailable due to "other" causes, such as inaccessible shorelines, extremely shallow depth, etc. This appendix explains how the different measures were calculated for the recreational fishing portion of the report. Similar methods were used for swimming and boating, the differences are explained in their respective chapters on model formation and estimation.

The raw availability measures for the state and county freshwater data were drawn from the supply variables database, developed for this project (See appendix 5.D). Relevant variables used in the calculations are:

Variable Name	Definition
COACRES _{i,j}	Total county area, in acres
STACRES _j	Total state area, in acres
COWATER _{i,j}	County freshwater area, in acres
STWATER _j	State freshwater area, in acres

where i indexes counties within a state and j indexes states. These data were used in combination with freshwater pollution data drawn from the Survey of Hatchery Fish (Vaughan and Russell, 1982, chapter 2) to develop pre-policy freshwater availability measures for recreational fishing. For

the six states that did not respond to the survey, predicted values obtained by regressing the RFF Water Quality Network model on the non-missing survey data were employed. Note that the pollution data is at the state level. Letting POLFRACT be the fraction of freshwater too polluted to support recreational fisheries, pre-policy, the ratios of fishable water to total area can be calculated as follows:

$$\text{COFWACRE}_{i,j} = (\text{COWATER}_{i,j} / \text{COACRES}_{i,j}) * \text{POLFRACT}_j$$

$$\text{STFWACRE}_j = (\text{STWATER}_j / \text{STACRES}_j) * \text{POLFRACT}_j$$

From this, it is straightforward to calculate the distance transformations:

$$\text{COFWDIST}_{i,j} = (\text{COFWACRE}_{i,j})^{-0.5}$$

$$\text{STFWDIST}_j = (\text{STFWACRE}_j)^{0.5},$$

following methods described in chapter 2. Since we had no data on restrictions on freshwater fishing availability for reasons other than pollution, no correction factor for "other" causes was included.

Three important assumptions are implicit in this method for calculating freshwater availability. The first is that areas of polluted water are randomly distributed within each state, a strong assumption at best. The second assumption is that, post-policy, all water will be fishable, and the third is that areas that are polluted pre-policy are perceived to be equivalent to dry land by both potential participants and active fishermen. The first two assumptions are required by the nature of the environmental quality data available to us, while the third is imposed to provide a parallel with the 1982 freshwater fishing work.

The coastal availability variables were calculated somewhat differently than the state and county freshwater measures. The data on pollution and "other" restrictions was drawn from the Dyson survey (See appendix 5.C), table 3. Since Great Lakes fishing restrictions were not

available for Indiana, we substituted the data for Illinois, since the two coasts (on Lake Michigan) are adjacent to one another.

The "raw" distances, before correcting for pollution and other causes, were calculated using a distance sweeper program. The program's inputs are a file of county FIPS codes and population centroid coordinates (latitude and longitude) for each county in the U.S., and a file of FIPS codes and population centroid coordinates for each coastal county in the U.S. For every U.S. county, the program then finds the nearest Great Lakes and marine coastal county, using the Euclidean distances between centroids, and produces a file containing the FIPS code of each "home" county and the FIPS/distance pairs for the closest Great Lakes and marine coastal counties. Since we were able to determine the county-level location of each fishing survey respondent's residence (See appendix 5.A), it was straightforward to match the survey data with the output from the sweeper program to produce "raw" distances (in miles) between the population centroid of each survey respondent's home county and the nearest Great Lakes and marine counties.

Given the raw distances and the FIPS codes of the closest coastal counties, the next step was to correct these distances. These calculations are shown below for the Great Lakes, the procedure for "inshore" and "offshore" marine coasts are analogous.

Given:

$RAWDIST_{i,j}$	Raw distance from county i to Great Lakes county j , from sweeper program.
$POLFRACT_{k,j}$	Pollution fraction, pre-policy, state k , county j . From Dyson survey, table 3. Note that within state k , all $POLFRACT_{k,i} = POLFRACT_{k,j}$, $i \neq j$.

$POSTFRAC_{k,j}$ Pollution fraction, post-policy, state k , county j . From Dyson survey, tables 6 and 7, post-BMP pollution.

$OTHFRAC_{k,j}$ "Other" fraction, from Dyson survey, table 3. Again, these are equal within state.

Then $GLDIST_{i,j} = RAWDIST_{i,j} * POLFRAC_{k,j}^{-1} * OTHFRAC_{k,j}^{-1}$ and
 $GLDIPO_{i,j} = RAWDIST_{i,j} * POSTFRAC_{k,j}^{-1} * OTHFRAC_{k,j}^{-1}$.

As with the state/county freshwater availability measures, this assumes that pollution is evenly distributed within a given state's coastline. It will generally overstate the difference between pre- and post-policy travel distances, especially when the pre-policy pollution fraction is high. See the text in the body of the chapter for an example.

APPENDIX 5.C

RECREATIONAL WATER AVAILABILITY IN THE UNITED STATES
THE IMPACT OF POLLUTION CONTROL

The Quality of the Environment Division at Resources for the Future (RFF) is currently working on a study to evaluate the recreational benefits of water pollution control programs. The first step in the study was to identify indicators of water quality which linked forward to individuals' decisions to participate in recreational activities -- specifically, marine fishing, and marine and freshwater swimming and boating. This range of potential indicators was then to be narrowed to those which might be linked back to the pollution discharges that effect ambient water quality. The final step would have been to find data for the indicators that were ultimately chosen--data that were spatially and temporally consistent with available recreational participation data.

Identifying a number of possible indicators used in individual participation decisions was not a problem. However, certain problems did arise when we turned to the second and third phases of our task. Because of the huge dilution and flushing rates to be found in the marine environment, it was difficult to locate physical and chemical indicators which could be linked back to specific pollution discharges. Even more fundamentally, finding data on marine and freshwater quality indicators that had been consistently monitored on a national level since 1972 proved impossible.

Data bases that contain consistent measurements of water, both temporally and spatially, for example, U.S. Geological Survey's WATER data STOrage and RETrieval system (WATSTORE), are limited because many of the parameters measured are hydrologic and cannot easily be used as water quality indicators. Moreover U.S.G.S. monitors only 345 stations nationwide, and these are all located on freshwater portions of major rivers.

Other data bases which include marine stations and collect water quality data on a national level, for example, the Environmental Protection Agency's STOrage and RETrieval of Parametric Water Quality Data (STORET), contain

inconsistent data, with gaps in certain areas of the country and over certain periods of time. Again, few parameters which would give us an indication of water quality are recorded, and limited quality control has been applied to the data, resulting in many apparent errors.

The U.S. Fish and Wildlife Service's "Ecological Characterization of Coastal Fisheries," concentrates on marine water quality. However, it does not include the whole U. S. coastline -- the east coast states from New Hampshire to North Carolina are missing.¹ In addition, the data in this study are derived from hundreds of sources, making it difficult to compare results from different regions of the country. An effort was undertaken to track down the underlying references in the hope of being able to construct a regionally comparable collection of marine water quality data; none were found.

One monitoring program initiated nationwide by the U.S. Environmental Protection Agency -- the U. S. Mussell Watch Program, has used consistent methods to measure pollutant levels in bivalves since 1975. However, Farrington and coauthors conclude that the Mussell Watch program is better viewed as a method for detecting areas with acute pollutant levels and that it "cannot and must not be viewed as a panacea for monitoring organic pollutants in the estuarine and coastal marine environment."²

In searching for national water quality data bases, evidence was found of good water quality monitoring programs and studies on the state level. On the basis of this evidence we concluded that in order to obtain estimates of marine and freshwater availability for recreational use that were consistent with our needs it would be necessary to obtain data directly from the states.

1. Personal communication with Martha Young, National Coastal Ecosystems Team, U.S. Fish and Wildlife Service, Slidell, LA.

2. Farrington, J.W., et. al. 1982. Hydrocarbons, Polychlorinated Biphenyls, and DDE in Mussels and Oysters from the U.S. Coast 1976-1978 - The Mussell Watch. Prepared for the U.S. Environmental Protection Agency (Woods Hole, MA, Woods Hole Oceanographic Institute).

Section I. RFF RECREATIONAL WATER AVAILABILITY SURVEY

To obtain data which would satisfy both conditions we were interested in -- a comprehensive assessment of water quality associated with participation decisions and linked to changes in pollution loads as regulated by existing pollution control legislation-- and to do so without making unreasonable demands on the time of state agencies, we felt it was necessary to design a questionnaire that went directly to the availability questions without seeking data on pollutant concentrations. Therefore, we undertook the RFF Recreational Water Availability Survey in which we asked officials in each state to estimate the percentage of total water area (or coastal miles as appropriate) in their state in which quality problems limited fishing, swimming, and boating during a base-year period of 1974-76. The chosen time period -- before the effects of the Federal water Pollution Control Act Amendments of 1972 would have been apparent -- provided our link with discharges and thus with pollution control Policy.

A copy of the survey instrument sent to coastal states may be found In Section V. The basic format and questions are the same for all states; however, we printed three separate questionnaire forms in order to ask only the questions that were appropriate, based on the combination of marine, Great Lakes and freshwater to be found in the particular state. Different sections asked questions about fishing in marine and Great Lakes waters, and boating and swimming in marine waters, freshwater and the Great Lakes. The format was consistent for all sections to avoid confusion, beginning with our estimation of each state's total water area (or beach or shoreline miles for swimming) and asking recipients to give rough percentages of this total area (or length) for which the recreational activity in question was limited. Two limitation categories were distinguished: that due to pollution and that due to reasons other than pollution. We then provided examples of pollution-related

reasons for limited use and noted that limitations did not necessarily have to involve official closings. This was followed by a section asking respondents to list the reasons for limitations other than pollution. (A complete list of the reasons provided by the states may be found in Section VI.

A brief description of separate sections of the complete questionnaire follows. Fuller explanations of the sources of water areas and beach or coastline lengths are to be found in appendices Sections VII and VIII.

Marine Recreation Fishing. We divided the state surface water areas into two groups, 1) bays, inlets and estuaries, and 2) coastal (derived by taking the sea-facing coastline of each state³ and multiplying it by three to get the area of a strip to three miles offshore).

Marine Swimming. We provided total length of beach along each state's marine coastline⁴ and asked the recipient to divide this number into public and private beach. If he/she, was unable to do this, we also provided a category where estimates of limitations for undifferentiated beach could be given.

Marine Recreational Boating. We used the same water area breakdown as in marine recreational fishing. In addition to this, we differentiated between small boats (in which water contact is a possibility) and large boats (in which water contact is limited).

Freshwater Swimming We were unable to find measurements of beach length by state for rivers and lakes. We assumed that swimming might occur in these water bodies whether there was a beach or not, so we provided an estimate of total freshwater shoreline (lakes and rivers) for each state Section VIII.

3. U.S. Bureau of the Census, Statistical Abstract of the United States: 1973 (Washington, D.C., Government Printing Office, 1973) p. 171.

4. U.S. Army Corps of Engineers, National Shoreline Study, Regional Inventory Report, Vols. I-V (Washington, D.C. Government Printing Office, 1971).

Again, we asked the recipient to divide this number between public and private. We also inserted an undifferentiated shoreline category for limitation percentages if the recipient was unable to divide shoreline between public and private.

Freshwater Recreational Boating. We provided each state with an estimate of total freshwater surface area (lakes, pond, rivers and streams) Sections VII and VIII and asked the respondent to consider limitation percentages for small boats as well as large boats.

Great Lakes Recreational Fishing. We provided a total surface water area for those parts of each Great Lake located within a state's boundaries.⁵

Great Lakes Swimming. We were able to obtain data which divided Great Lakes beaches into public and private;⁶ therefore we provided total length of both public and private beach for each state and asked the recipients to give limitation percentages for each category.

Great Lakes Recreational Boating. Once again, recipients were asked to provide limitation percentages for the total Great Lakes surface area in their state differentiated for small and large boats.

Protections of Water Quality Changes. The recipients were asked to take the pollution limitation percentage for each category they were able to answer and alter it to reflect, in their best judgement, any changes in recreational water availability that might occur after full implementation of each stage specified in the latest version of the federal water pollution control program. This was prefaced by an explanation of each stage and the specific pollutants that would be affected by full implementation of that stage. We followed this with an example of how the projection section should be completed.

5. U. S. bureau of the Census, Statistical Abstract of the United States: 1973, p. 173.

6. U.S. Army Corps of Engineers, National Shoreline Study, Regional
(Footnote continued)

The survey was sent on September 1, 1983, to 230 state officials in the 48 states within the continental United States. Since the relevant responsibilities are often handled by different departments within a state, surveys were sent to each potentially appropriate division of the state government. Table 1 lists the number of surveys sent to each state. Typically a state received four surveys; several states had as few as two addresses, but some as many as eight or nine. The mailing list was comprised of state officials within the appropriate divisions of state Departments of Environmental Conservation, Natural Resources, Public Health, Parks and Recreation, and Water Resources. In addition, state Water Resources Research Centers within universities and state Water Commissions were contacted, as well as regional offices of the U.S. Environmental Protection Agency and the U.S. Geological Survey.

Section II. SURVEY RESULTS: BASE-YEAR CONDITIONS.

The response was very positive. Many state officials took the time and effort to complete the survey, basing their limitation percentage estimates on actual measurements of water quality. In all, we received 87 surveys representing 46 states. Of course, not all returned surveys were filled out completely since some officials had the information to answer only certain sections. Table 2 lists the categories responded to by each state.

We averaged the base-year limitation estimates from each state. These averages were used to represent the percentage of each state's total water area available and unavailable for the recreational activities. Tables 3 through 5 show these base-year averages broken down by recreational category and water area.

6. (continued)

Inventory Report, Great Lakes Region, Vol. 7 (Washington, D.C., Government Printing Office, 1971).

Table 1. Number of Surveys Sent to Each State

States with Marine Water and Shoreline		States with Great Lakes Water and Shoreline		States with Neither Marine nor Great Lakes Water and Shoreline	
State	Surveys Sent	State	Surveys Sent	State	Surveys Sent
ALABAMA	7	ILLINOIS	9	ARIZONA	5
CALIFORNIA	8	INDIANA	5	ARKANSAS	4
CONNECTICUT	4	MICHIGAN	6	COLORADO	4
DELAWARE	6	MINNESOTA	6	IDAHO	3
FLORIDA	5	OHIO	5	IOWA	4
GEORGIA	6	PENNSYLVANIA	5	KANSAS	5
LOUISIANA	8	WISCONSIN	5	KENTUCKY	4
MAINE	5			MISSOURI	4
MARYLAND	5			MONTANA	4
MASSACHUSETTS	7			NEBRASKA	2
MISSISSIPPI	4			NEVADA	4
NEW HAMPSHIRE	5			NEW MEXICO	5
NEW JERSEY	6			NO. DAKOTA	2
NEW YORK ^a	6			OKLAHOMA	3
NO. CAROLINA	5			SO. DAKOTA	2
OREGON	6			TENNESSEE	3
RHODE ISLAND	7			UTAH	3
SO. CAROLINA	5			VERMONT	2
TEXAS	6			WEST VIRGINIA	3
VIRGINIA	5			WYOMING	2
WASHINGTON	5				
(States 21)		(States 7 ^a ,		(States 20)	
(Surveys 121)		(Surveys 41)		(Surveys 68)	

^aNew York is the only state having both marine and Great Lakes coasts.

Table 2. Recreational Categories Responded to By Each State

State	Marine			Great Lakes			Freshwater	
	Fish.	Swim.	Boat.	Fish.	Swim.	Boat.	Swim.	Boat.
ALABAMA	x	x	x	-	-	-	n.a.	n.a.
ARIZONA	-	-	-	-	-	-	x	x
ARKANSAS	-	-	-	-	-	-	x	x
CALIFORNIA	x	n.a.	x	-	-	-	x	x
COLORADO	-	-	-	-	-	-	x	x
CONNECTICUT	x	x	x	-	-	-	x	x
DELAWARE	x	x	x	-	-	-	x	x
FLORIDA	x	x	x	-	-	-	n.a.	n.a.
GEORGIA	x	x	x	-	-	-	n.a.	n.a.
IDAHO	-	-	-	-	-	-	x	x
ILLINOIS	-	-	-	x	x	x	x	x
INDIANA	-	-	-	n.a.	x	x	n.a.	n.a.
IOWA	-	-	-	-	-	-	x	x
KANSAS	-	-	-	-	-	-	x	x
KENTUCKY	-	-	-	-	-	-	x	x
LOUISIANA	x	x	x	-	-	-	x	x
MAINE	x	x	x	-	-	-	x	x
MARYLAND	x	x	n.a.	-	-	-	n.a.	n.a.
MASSACHUSETTS	x	n.a.	n.a.	-	-	-	n.a.	n.a.
MICHIGAN	-	-	-	x	x	x	x	x
MINNESOTA	-	-	-	x	x	x	x	x
MISSISSIPPI	x	x	x	-	-	-	x	x
MISSOURI	-	-	-	-	-	-	x	x
MONTANA	-	-	-	-	-	-	x	x
NEBRASKA	-	-	-	-	-	-	x	x
NEVADA	-	-	-	-	-	-	n.a.	n.a.
NEW HAMPSHIRE	x	x	x	-	-	-	x	x
NEW JERSEY	x	x	x	-	-	-	x	x
NEW MEXICO	-	-	-	-	-	-	x	x
NEW YORK	x	n.a.	n.a.	x	n.a.	n.a.	n.a.	n.a.
NORTH CAROLINA	x	x	x	-	-	-	x	x
NORTH DAKOTA	-	-	-	-	-	-	x	x
OHIO	-	-	-	x	x	x	x	x
OKLAHOMA	-	-	-	-	-	-	x	x
OREGON	x	x	x	-	-	-	x	x
PENNSYLVANIA	-	-	-	x	x	x	n.a.	x
RHODE ISLAND	x	x	x	-	-	-	n.a.	x
SOUTH CAROLINA	x	x	x	-	-	-	x	x
SOUTH DAKOTA	-	-	-	-	-	-	x	x
TENNESSEE	-	-	-	-	-	-	x	x
TEXAS	x	x	x	-	-	-	x	x
UTAH	-	-	-	-	-	-	x	x
VERMONT	-	-	-	-	-	-	x	x
VIRGINIA	x	x	x	-	-	-	x	x
WASHINGTON	x	x	x	-	-	-	x	x
WEST VIRGINIA	-	-	-	-	-	-	n.a.	n.a.
WISCONSIN	-	-	-	x	x	x	x	x
WYOMING	-	-	-	-	-	-	x	x
Percentage of total possible responses	100%	86%	86%	88%	88%	88%	77%	81%

x = At least one response received; n.a. = No response available; - = Not applicable.

Table 3. Recreational Fishing: Reported Availability of Water During the Base-Year Period, 1974-76
(All data are percentages of water areas)

State	Marine								Great Lakes			
	Bays and Estuaries				Coastal							
	Poll ^a	Other ^b	Total Un-avail ^c	Total Avail ^d	Poll	Other	Total Un-avail	Total Avail	Poll	Other	Total Un-avail	Total Avail
ALABAMA	2.5	10.0	12.5	87.5	0.0	0.0	0.0	100.0	--	--	--	--
CALIFORNIA	0.0	0.0	0.0	100.0	0.0	1.6	1.6	98.4	--	--	--	--
CONNECTICUT	25.0	50.0	75.0	25.0	0.0	0.0	0.0	100.0	--	--	--	--
DELAWARE	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	--	--	--	--
FLORIDA	5.0	17.5	22.5	77.5	0.0	5.0	5.0	95.0	--	--	--	--
GEORGIA	0.5	0.5	1.0	99.0	0.0	0.0	0.0	100.0	--	--	--	--
ILLINOIS	--	--	--	--	--	--	--	--	26.3	7.5	33.8	66.2
INDIANA	--	--	--	--	--	--	--	--	n.a.	n.a.	n.a.	n.a.
LOUISIANA	0.0	35.0	35.0	65.0	0.0	35.0	35.0	65.0	--	--	--	--
MAINE	5.0	0.0	5.0	95.0	1.0	0.0	1.0	99.0	--	--	--	--
MARYLAND	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	--	--	--	--
MASSACHUSETTS	1.0	0.0	1.0	99.0	0.0	0.0	0.0	100.0	--	--	--	--
MICHIGAN	--	--	--	--	--	--	--	--	1.0	0.0	1.0	99.0
MINNESOTA	--	--	--	--	--	--	--	--	2.0	0.0	2.0	98.0
MISSISSIPPI	15.0	0.0	15.0	85.0	0.0	0.0	0.0	100.0	--	--	--	--
NEW HAMPSHIRE	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	--	--	--	--
NEW JERSEY	6.7	0.7	7.4	92.6	3.3	4.3	7.6	92.4	--	--	--	--
NEW YORK	7.5	0.0	7.5	92.5	0.0	0.0	0.0	100.0	80.0	0.0	00.0	20.0
NO. CAROLINA	15.0	7.5	22.5	77.5	2.5	2.5	5.0	95.0	--	--	--	--
OHIO	--	--	--	--	--	--	--	--	10.0	15.0	25.0	75.0
OREGON	7.0	10.0	17.0	83.0	0.0	0.0	0.0	100.0	--	--	--	--
PENNSYLVANIA	--	--	--	--	--	--	--	--	10.0	0.0	10.0	90.0
RHODE ISLAND	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	--	--	--	--
SO. CAROLINA	11.7	0.0	11.7	88.3	0.0	0.0	0.0	100.0	--	--	--	--
TEXAS	5.1	7.5	12.6	87.4	2.5	5.0	7.5	92.5	--	--	--	--
VIRGINIA	15.0	0.0	15.0	85.0	0.0	0.0	0.0	100.0	--	--	--	--
WASHINGTON	0.5	5.0	5.5	94.5	0.0	0.0	0.0	100.0	--	--	--	--
WISCONSIN	--	--	--	--	--	--	--	--	34.5	0.0	34.5	65.5

n.a. = No response available: -- = Not applicable.

^aColumn heading refers to percentage of total water area with limitations due to pollution.

^bColumn heading refers to percentage of total water area with limitations due to reasons other than pollution.

^cColumn heading refers to percentage of total water area unavailable to recreational fishing.

^dColumn heading refers to percentage of total water area available (no limitations) to recreational fishing.

Table 4. Swimming: Reported Availability of Beaches or Shoreline During the Base-Year Period, 1974-76

(All data are percentage of beaches or shoreline)

State	Freshwater Shoreline				Marine Beaches				Great Lakes Beaches			
	Poll ^a	Other ^b	Total Un-avail ^c	Total Avail ^d	Poll	Other	Total Un-avail	Total Avail	Poll	Other	Total Un-avail	Total Avail
ALABAMA	n.a.	n.a.	n.a.	n.a.	0.5	9.8	10.3	89.7	--	--	--	--
ARIZONA	3.5	37.5	41.0	59.0	--	--	--	--	--	--	--	--
ARKANSAS	45.0	0.0	45.0	55.0	--	--	--	--	--	--	--	--
CALIFORNIA	1.3	5.2	6.5	93.5	n.a.	n.a.	n.a.	n.a.	--	--	--	--
COLORADO	1.9	38.1	40.0	60.0	--	--	--	--	--	--	--	--
CONNECTICUT	40.0	10.0	50.0	50.0	13.1	23.8	36.9	63.1	--	--	--	--
DELAWARE	18.3	56.2	74.5	25.5	0.0	0.0	0.0	100.0	--	--	--	--
FLORIDA	n.a.	n.a.	n.a.	n.a.	0.0	0.0	0.0	100.0	--	--	--	--
GEORGIA	n.a.	n.a.	n.a.	n.a.	0.0	3.6	3.6	96.4	--	--	--	--
IDaho	14.0	16.0	30.0	70.0	--	--	--	--	--	--	--	--
ILLINOIS	4.3	28.2	32.5	67.5	--	--	--	--	14.7	0.0	14.7	85.3
INDIANA	n.a.	n.a.	n.a.	n.a.	--	--	--	--	10.0	0.0	10.0	90.0
IOWA	50.0	10.0	60.0	40.0	--	--	--	--	--	--	--	--
KANSAS	2.5	47.5	50.0	50.0	--	--	--	--	--	--	--	--
KENTUCKY	9.5	20.5	30.0	70.0	--	--	--	--	--	--	--	--
LOUISIANA	10.0	10.0	20.0	80.0	10.0	10.0	20.0	80.0	--	--	--	--
MAINE	1.0	25.0	26.0	74.0	1.0	1.0	2.0	98.0	--	--	--	--
MARYLAND	n.a.	n.a.	n.a.	n.a.	0.1	75.0	75.1	24.9	--	--	--	--
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--
MICHIGAN	1.0	0.0	1.0	99.0	--	--	--	--	1.0	0.0	1.0	99.0
MINNESOTA	20.5	0.0	20.5	79.5	--	--	--	--	0.0	0.0	0.0	100.0
MISSISSIPPI	20.0	40.0	60.0	40.0	40.0	50.0	90.0	10.0	--	--	--	--
MISSOURI	3.5	34.1	37.6	62.4	--	--	--	--	--	--	--	--
MONTANA	0.0	1.0	1.0	99.0	--	--	--	--	--	--	--	--
NEBRASKA	20.5	37.5	58.0	42.0	--	--	--	--	--	--	--	--
NEVADA	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
NEW HAMPSHIRE	12.4	0.1	12.5	87.5	0.0	0.0	0.0	100.0	--	--	--	--
NEW JERSEY	50.0	10.0	60.0	40.0	15.0	10.4	25.4	74.6	--	--	--	--
NEW MEXICO	0.4	0.3	0.7	99.3	--	--	--	--	--	--	--	--
NEW YORK	5.0	0.0	5.0	95.0	80.0	0.0	80.0	20.0	n.a.	n.a.	n.a.	n.a.
N. CAROLINA	10.0	48.0	58.0	42.0	5.0	0.0	5.0	95.0	--	--	--	--
N. DAKOTA	38.0	24.0	62.0	38.0	--	--	--	--	--	--	--	--
OHIO	20.0	25.0	45.0	55.0	--	--	--	--	10.0	14.5	24.5	75.5
OKLAHOMA	0.0	5.0	5.0	95.0	--	--	--	--	--	--	--	--
OREGON	0.5	50.0	50.5	49.5	0.0	15.0	15.0	85.0	--	--	--	--
PENNSYLVANIA	n.a.	n.a.	n.a.	n.a.	--	--	--	--	1.2	0.0	1.2	98.8
RHODE ISLAND	n.a.	n.a.	n.a.	n.a.	15.0	0.0	15.0	85.0	--	--	--	--
S. CAROLINA	4.5	0.0	4.5	95.5	0.2	0.0	0.2	99.8	--	--	--	--
S. DAKOTA	40.0	20.0	60.0	40.0	--	--	--	--	--	--	--	--
TENNESSEE	3.3	44.0	47.3	52.7	--	--	--	--	--	--	--	--
TEXAS	30.8	0.0	30.8	69.2	5.1	7.5	12.6	87.4	--	--	--	--
UTAH	5.0	5.0	10.0	90.0	--	--	--	--	--	--	--	--
VERMONT	5.0	0.0	5.0	95.0	--	--	--	--	--	--	--	--
VIRGINIA	12.1	5.0	17.1	82.9	0.5	3.7	4.2	95.8	--	--	--	--
WASHINGTON	1.5	7.5	9.0	91.0	2.6	49.9	52.5	47.5	--	--	--	--
WEST VIRGINIA	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
WISCONSIN	2.1	35.8	37.9	62.1	--	--	--	--	2.6	83.0	85.6	14.4
WYOMING	10.3	73.9	84.2	15.8	--	--	--	--	--	--	--	--

n.a. : No response available; -- : Not applicable.

^aColumn heading refers to percentage of total beach or shoreline miles limited due to pollution.^bColumn heading refers to percentage of total beach or shoreline miles limited due to reasons other than pollution.^cColumn heading refers to percentage of total beach or shoreline miles unavailable to recreational swimming.^dColumn heading refers to percentage of total beach or shoreline miles available (no limitations) to recreational swimming.

Table 5. Recreational Boating: Reported Availability of Water During the Base-Year Period, 1974-76
(All data are percentages of water areas)

State	Freshwater								Great Lakes							
	Small Boats				Large Boats				Small Boats				Large Boats			
	Poll ^a	Other ^b	Total Un-avail ^c	Total Avail ^d	Poll	Other	Total Un-avail	Total Avail	Poll	Other	Total Un-avail	Total Avail	Poll	Other	Total Un-avail	Total Avail
ALABAMA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
ARIZONA	0.0	23.8	23.0	76.2	0.0	19.5	19.5	80.5	--	--	--	--	--	--	--	--
ARKANSAS	0.0	5.0	5.0	95.0	0.0	37.5	31.5	62.5	--	--	--	--	--	--	--	--
CALIFORNIA	0.3	5.2	5.5	94.5	0.2	12.8	13.0	87.0	--	--	--	--	--	--	--	--
COLORADO	2.0	0.0	2.0	98.0	0.0	0.0	0.0	100.0	--	--	--	--	--	--	--	--
CONNECTICUT	0.0	20.0	20.0	80.0	0.0	40.0	40.0	40.0	--	--	--	--	--	--	--	--
DELAWARE	0.0	20.0	20.0	80.0	0.0	95.0	95.0	5.0	--	--	--	--	--	--	--	--
FLORIDA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
GEORGIA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
IDAHO	11.5	10.0	21.5	78.5	4.2	20.0	24.2	15.8	--	--	--	--	--	--	--	--
ILLINOIS	11.0	20.0	31.0	69.0	11.0	40.0	51.0	49.0	0.5	67.5	68.0	32.0	0.5	20.0	20.5	79.5
INDIANA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
IOWA	0.0	10.0	10.0	90.0	0.0	10.0	10.0	90.0	--	--	--	--	--	--	--	--
KANSAS	2.5	31.5	40.0	60.0	2.5	70.0	72.5	21.5	--	--	--	--	--	--	--	--
KENTUCKY	1.0	10.0	11.0	89.0	1.0	10.0	11.0	89.0	--	--	--	--	--	--	--	--
LOUISIANA	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	--	--	--	--	--	--	--	--
MAINE	2.0	2.0	1.0	96.0	1.0	5.0	6.0	94.0	--	--	--	--	--	--	--	--
MARYLAND	n.a.	n.a.	11.0	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
MICHIGAN	0.1	5.0	5.1	94.9	0.0	5.0	5.0	95.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
MINNESOTA	10.0	0.0	10.0	90.0	10.0	0.0	10.0	90.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
MISSISSIPPI	20.0	40.0	60.0	40.0	0.0	60.0	60.0	40.0	--	--	--	--	--	--	--	--
MISSOURI	0.5	14.5	15.0	85.0	0.5	19.5	20.0	80.0	--	--	--	--	--	--	--	--
MONTANA	2.5	0.0	2.5	91.5	2.5	0.0	2.5	91.5	--	--	--	--	--	--	--	--
NEBRASKA	25.0	45.0	10.0	30.0	5.0	45.0	50.0	50.0	--	--	--	--	--	--	--	--
NEVADA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
NEW HAMPSHIRE	0.0	3.0	3.0	97.0	0.0	3.0	3.0	91.0	--	--	--	--	--	--	--	--
NEW JERSEY	10.0	30.0	40.0	60.0	10.0	50.0	60.0	40.0	--	--	--	--	--	--	--	--
NEW MEXICO	0.0	13.0	13.0	87.0	0.0	23.0	23.0	11.0	--	--	--	--	--	--	--	--
NEW YORK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NO. CAROLINA	7.5	0.0	1.5	92.5	5.0	2.5	1.5	92.5	--	--	--	--	--	--	--	--
NORTH DAKOTA	5.0	20.0	25.0	15.0	0.0	30.0	30.0	10.0	--	--	--	--	--	--	--	--
OHIO	15.0	20.0	35.0	65.0	3.0	10.0	13.0	87.0	1.0	4.0	5.0	95.0	0.0	0.0	0.0	100.0
OKLAHOMA	0.0	5.0	5.0	95.0	0.0	5.0	5.0	95.0	--	--	--	--	--	--	--	--
OREGON	0.0	3.5	3.5	96.5	0.0	3.5	3.5	96.5	--	--	--	--	--	--	--	--
PENNSYLVANIA	15.0	10.0	25.0	15.0	10.0	10.0	20.0	80.0	0.5	35.0	35.5	64.5	0.5	25.5	26.0	74.0
RHODE ISLAND	0.0	10.0	10.0	90.0	0.0	10.0	10.0	90.0	--	--	--	--	--	--	--	--
SO. CAROLINA	3.0	0.0	3.0	91.0	0.0	0.0	0.0	100.0	--	--	--	--	--	--	--	--
SOUTH DAKOTA	5.0	5.0	10.0	90.0	5.0	13.0	15.0	85.0	--	--	--	--	--	--	--	--
TENNESSEE	0.6	6.0	6.6	93.4	0.0	9.0	9.0	91.0	--	--	--	--	--	--	--	--
TEXAS	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	--	--	--	--	--	--	--	--
UTAH	5.0	10.0	15.0	85.0	5.0	10.0	15.0	85.0	--	--	--	--	--	--	--	--
VERMONT	2.0	0.0	2.0	98.0	0.0	0.0	0.0	100.0	--	--	--	--	--	--	--	--
VIRGINIA	8.7	11.7	20.4	79.6	2.0	20.0	22.0	18.0	--	--	--	--	--	--	--	--
WASHINGTON	1.0	0.5	1.5	98.5	1.0	5.0	6.0	94.0	--	--	--	--	--	--	--	--
WEST VIRGINIA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	--	--	--	--	--	--	--	--
WISCONSIN	0.0	54.2	54.2	45.8	0.0	59.2	59.2	40.8	0.2	0.0	0.2	99.8	0.0	0.0	0.0	100.0
WYOMING	5.0	15.0	20.0	80.0	5.0	25.0	30.0	70.0	--	--	--	--	--	--	--	--

Table 5. (Continued)

State	Marine															
	Bays and Estuaries								Coastal							
	Small Boats				Large Boats				Small Boats				Large Boats			
	Poll ^a	Other ^b	Total Un-avail ^c		Poll	Other	Total Un-avail		Poll	Other	Total Un-avail		Poll	Other	Total Un-avail	
			avail ^d	Avail ^d			avail	avail			avail	Avail			avail	Avail
ALABAMA	0.0	0.0	0.0	100.0	0.0	15.0	15.0	85.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
CALIFORNIA	0.5	0.5	1.0	99.0	0.5	15.0	1.0	99.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
CONNECTICUT	20.0	0.0	20.0	80.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
DELAWARE	0.0	0.0	0.0	100.0	0.0	5.0	5.0	95.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
FLORIDA	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
GEORGIA	0.0	1.0	1.0	99.0	0.0	1.0	1.0	99.0	0.0	1.0	1.0	99.0	0.0	1.0	1.0	99.0
LOUISIANA	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
MAINE	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
MARYLAND	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MISSISSIPPI	30.0	20.0	50.0	50.0	0.0	40.0	40.0	60.0	0.0	0.0	0.0	100.0	0.0	40.0	40.0	60.0
NEW HAMPSHIRE	0.0	10.0	10.0	90.0	0.0	25.0	25.0	15.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
NEW JERSEY	0.8	2.2	3.0	97.0	0.5	2.5	3.0	97.0	0.8	2.2	3.0	97.0	0.5	2.5	3.0	97.0
NEW YORK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NO. CAROLINA	2.5	0.0	2.5	97.5	2.5	0.0	2.5	97.5	2.5	0.0	2.5	97.5	1.0	0.0	1.0	99.0
OREGON	0.0	5.0	5.0	95.0	4.0	5.0	5.0	95.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
RHODE ISLAND	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
SO. CAROLINA	2.3	0.0	2.3	97.7	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
TEXAS	6.0	7.5	13.5	86.5	0.0	7.5	7.5	92.5	3.5	5.0	8.5	91.5	0.0	5.0	5.0	95.0
VIRGINIA	0.5	0.0	0.5	99.5	0.0	0.0	0.5	99.5	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
WASHINGTON	0.1	17.0	17.1	82.9	0.0	0.7	0.7	99.3	0.0	33.7	33.7	60.3	0.0	0.3	0.3	99.7

n.a. = No response available; -- = Not applicable

^aColumn heading refers to percentage of total water area with limitations due to pollution.^bColumn heading refers to percentage of total water area with limitations due to reasons other than pollution.^cColumn heading refers to percentage of total water area unavailable to recreational boating.^dColumn heading refers to percentage of total water area available (no limitations) to recreational boating.

As might be expected, few states had pollution limitations on fishing in coastal waters, and those that did had only slight limitations--less than 3.3 percent. Pollution restrictions on fishing were more common and affected larger percentages of potentially available water in bays and estuaries. Connecticut--the state with the most restricted area--had a 25 percent limitation estimate. Other states with higher than average pollution limitations (that is, greater than 5.8 percent) in bays and estuaries included those with major industrial ports--New York, New Jersey, and Mississippi--and states with many barrier islands--Virginia, North Carolina, and South Carolina.

These limitation estimates were small when compared to Great Lakes states. New York estimated 80 percent of its potential Great Lakes fishery was unavailable due to pollution, while Wisconsin and Illinois estimated 34.5 and 26.3 percent, respectively.

For freshwater swimming, pollution limitations averaged 14 percent of shoreline miles. States with estimates above this average were clustered in the northeast--New Hampshire, Connecticut, New Jersey, and Delaware--and north central--Iowa, Minnesota, North Dakota, South Dakota, and Nebraska--sections of the country. Arkansas (45 percent), Texas (30.8 percent), and Mississippi (20 percent) also had severe freshwater swimming restrictions.

Swimming in marine waters was not nearly as restricted by pollution. The average limitation percent was ten. States with higher than average estimates included Rhode Island (15 percent), Connecticut (13.1 percent), New York (80 percent),⁷ New Jersey (15 percent), and Mississippi (40 percent).

in the Great Lakes, the highest pollution limitations on swimming occurred in Illinois, Indiana and Ohio; States with very urban, industrialized shorelines.

7. New York's unusually high pollution limitation percentage was due to a series of acute polluting events which occurred during the base-year period.

It is not surprising that average pollution restrictions on boating were very low. Except for freshwater areas in several of the Great Lakes states (limitation averages around 10 percent), there were almost no pollution-related restrictions on large boats in any water areas. Pollution-related restrictions on use of small boats were greatest in the bay and estuarine waters of Connecticut and Mississippi--20 and 30 percent, respectively--and in freshwater bodies in several of the Great Lakes states (Illinois, 11.0 percent, Ohio, 15 percent, and Pennsylvania, 15 Percent), in Mississippi (20 percent), Nebraska (25 percent), and Idaho (11.5 percent).

Section III. SURVEY RESULTS: PROJECTED IMPROVEMENTS

In the final section of the questionnaire, respondents were asked to project how conditions would change as the requirements of the Clean Water Act (CWA) of 1982 were implemented. Using the base-year state averages of pollution limitations and these projections, we can calculate percentage improvement in conditions attributable to the Act. As explained in the survey, the first stage, Best Practicable Technology (BPT), addressed conventional pollutant discharges (for example, 30D, oil and grease, suspended solids, and dissolved solids) and should have been fully implemented in most states by 1982.⁸ In the second stage, Best Available Technology (BAT) concentrates on alleviating problems caused by toxic pollutants (for example, pesticides, heavy metals, PCBs, and so forth) and non-conventional pollutants (for example, COD, ammonia, sulfides, nitrogen and phosphorus). At the same time, the Best Conventional Technology (BCT) requirements were intended to improve the pictures for conventional pollutants (for example, pH and fecal. coliform, as well as those already mentioned above). Both BAT and BCT are to be implemented at the same time, and their results were almost certainly

8. Council on Environmental Quality, Environmental Quality 1982 (Washington, D.C., Government Printing Office, 1982) p. 86.

not fully realized by the states at the time of the survey.⁹

Any plans by the states to alleviate non-point sources of pollution (for example, agricultural and urban run-off) would be considered Best Management Practices (BMP), for our purposes the third stage in the implementation of the CWA. Most states have probably not yet implemented this stage, so that projections of resulting improvements are probably quite rough.

Tables 6 through 13 show how states estimated their average base-year pollution limitations would be affected by implementation of each of these stages. For each activity and category of water, we show for each state the base-year pollution-related limitation and the limitation remaining after implementation of each stage just described. Under each remaining restriction percent, we show in parentheses the incremental reduction in limitation represented by the change. The final column entry for each state under each activity/water category heading is the total percent reduction in pollution-related limitation projected to result from implementation of all stages through best management practices.

In table 14, we summarize these incremental improvement data by showing average percent incremental improvements by water, category, stage of control and recreation activity. The average projected result of full control is also shown. For each combination of recreational activity and water category the number of states reflected in the reported averages is shown as "N". This number reflects the number of states reporting some pollution-related restrictions in that water category relevant to that activity in the base-year period. Notice that some of these N's are very small (for example, N=2 in the case of Great Lakes and Coastal Marine water available for use of large boats.)

9. Council on Environmental Quality, Environmental Quality 1982, p. 82.

Table 6. Marine Recreational Fishing: Projected Pollution Limitation Percentages and Improvements After Pollution Control
(All data in percent terms)

State	Bays and Estuaries					Coastal				
	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base- Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
ALABAMA	2.5	1.0 (60.0) ^f	0.5 (50.0) ^f	0.5 (0) ^f	80.0	0.0	0.0	0.0	0.0	0.0
CALIFORNIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONNECTICUT	25.0	23.5 (6.0)	8.7 (63.0)	8.7 (0)	65.2	0.0	0.0	0.0	0.0	0.0
DELAWARE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLORIDA ^g	5.0	3.15 (39.0)	2.5 (21.0)	2.15 (14.0)	57.0	0.0	0.0	0.0	0.0	0.0
GEORGIA	0.5	0.5 (0)	0.5 (0)	0.5 (0)	0.0	0.0	0.0	0.0	0.0	0.0
LOUISIANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINE ^g	5.0	3.15 (37.0)	2.5 (21.0)	2.15 (14.0)	57.0	1.0	0.86 (14.0)	0.63 (26.7)	0.58 (7.9)	42.0
MARYLAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MASSACHUSETTS ^g	1.0	0.63 (37.0)	0.5 (21.0)	0.43 (14.0)	57.0	0.0	0.0	0.0	0.0	0.0
MISSISSIPPI	15.0	13.0 (13.3)	13.0 (0)	10.0 (23.1)	33.3	0.0	0.0	0.0	0.0	0.0
NEW HAMPSHIRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW JERSEY	6.7	3.0 (55.2)	3.0 (0)	2.2 (26.7)	67.1	3.3	2.0 (39.4)	2.0 (0)	1.3 (35.0)	60.6
NEW YORK ^g	7.5	4.7 (37.0)	3.7 (21.0)	3.18 (14.0)	57.3	0.0	0.0	0.0	0.0	0.0
N. CAROLINA	15.0	15.0 (0)	10.0 (33.3)	5.0 (50.0)	66.7	2.5	2.5 (0)	2.5 (0)	2.5 (0)	0.0
OHIO	7.0	0.0 (100)	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
RHODE ISLAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO. CAROLINA	11.7	7.0 (40.1)	7.0 (0)	2.3 (61.1)	80.3	0.0	0.0	0.0	0.0	0.0
TEXAS	5.1	5.1 (0)	3.8 (25.5)	3.8 (0)	25.5	2.5	2.5 (0)	1.5 (40.0)	1.5 (0)	40.0
VIRGINIA	15.0	0.0 (100)	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
WASHINGTON ^g	0.5	0.32 (37.0)	0.25 (21.0)	0.21 (14.0)	58.0	0.0	0.0	0.0	0.0	0.0

^aBase-year pollution is percentage of water area unavailable for fishing due to pollution in base period (table 3).

^bAverage percentage of water area unavailable for fishing due to pollution after implementation of best practicable technology.

^cSame measure after implementation of best available/best conventional technology.

^dSame measure after addition of best management practices for control of nonpoint sources.

^eTotal improvement = [(Base-year pollution limitation - Post BMP pollution limitation) / Base-year pollution limitation] x 100.

^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

^gIndividual state was unable to estimate projections. We calculated an average percent change for each category and applied this to the state's base-year limitation estimate.

Table 7. Great Lakes Recreational Fishing: Projected Pollution Limitation Percentages and Improvements After Pollution Control
(All data in percent terms)

State	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e
ILLINOIS	26.3	1.0 (96.1) ^f	1.0 (0)	1.0 (0)	96.1
INDIANA	n.a.	n.a.	n.a.	n.a.	n.a.
MICHIGAN	1.0	0.0 (100)	0.0	0.0	100.0
MINNESOTA	2.0	1.0 (50.0)	1.0 (0)	0.0 (100.0)	100.0
NEW YORK ^g	80.0	34.0 (57.5)	25.5 (25.0)	13.5 (47.0)	83.1
OHIO	10.0	10.0 (0)	3.0 (20.0)	5.0 (37.5)	50.0
PENNSYLVANIA	10.0	10.0 (0)	2.0 (80.0)	1.0 (50.0)	90.0
WISCONSIN	34.5	0.0 (100)	0.0	0.0	100.0

n.a. = No response available.

^aBase-year pollution is percentage of water area unavailable for fishing due to pollution in base period (table 3).

^bAverage percentage of water area unavailable for fishing due to pollution after implementation of best practicable technology.

^cSame measure after implementation of best available/best conventional technology.

^dSame measure after addition of best management practices for control of nonpoint sources.

^eTotal improvement = [(Base-year pollution limitation - Post BMP pollution limitation) / Base-year pollution limitation] x 100

^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

^gIndividual state was unable to estimate projections. We calculated an average percent change for each category and applied this to the state's base-year, limitation estimate.

Table 3. Marine and Great Lakes Swimming: Projected Pollution Limitation Percentages and Improvements After Pollution Control
(All data in percent terms)

State	Marine					Great Lakes				
	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base- Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
ALABAMA	0.5	0.5 (0) ^f	0.5 (0) ^f	0.25 (50.0) ^f	50.0	—	—	—	—	—
CALIFORNIA	n.a.	n.a.	n.a.	n.a.	n.a.	—	—	—	—	—
CONNECTICUT ^g	13.1	10.0 (23.4)	9.0 (9.8)	6.4 (28.6)	51.1	—	—	—	—	—
DELAWARE	0.0	0.0	0.0	0.0	0.0	—	—	—	—	—
FLORIDA	0.0	0.0	0.0	0.0	0.0	—	—	—	—	—
GEORGIA	0.0	0.0	0.0	0.0	0.0	—	—	—	—	—
ILLINOIS	—	—	—	—	—	14.7	0.0 (100)	0.0	0.0	100.0
INDIANA	—	—	—	—	—	10.0	0.0 (100)	0.0	0.0	100.0
LOUISIANA ^h	10.0	7.7 (23.4)	6.95 (9.8)	4.3 (28.6)	50.0	—	—	—	—	—
MAINE	1.0	0.0 (100)	0.0	0.0	100.0	—	—	—	—	—
MARYLAND ⁱ	0.06	0.046 (23.4)	0.041 (9.8)	0.03 (28.6)	50.0	—	—	—	—	—
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	—	—	—	—	—
MICHIGAN	—	—	—	—	—	1.0	0.0 (100)	0.0	0.0	100.0
MINNESOTA	—	—	—	—	—	0.0	0.0	0.0	0.0	0.0
MISSISSIPPI	40.0	30.0 (25.0)	30.0 (0)	15.0 (50.0)	62.5	—	—	—	—	—
NEW HAMPSHIRE	0.0	0.0	0.0	0.0	0.0	—	—	—	—	—
NEW JERSEY	15.0	10.6 (29.3)	8.6 (18.9)	6.5 (24.4)	56.7	—	—	—	—	—
NEW YORK ^j	30.0	61.3 (23.4)	55.3 (9.8)	39.5 (28.6)	50.6	3.4	n.a.	3.4	3.4	n.a.
N.C. CAROLINA	5.0	5.0 (0)	5.0 (0)	5.0 (0)	0.0	—	—	—	—	—
OHIO	—	—	—	—	—	10.0	10.0 (0)	8.0 (20.0)	8.0 (0)	20.0
OREGON	0.0	0.0	0.0	0.0	0.0	—	—	—	—	—
PENNSYLVANIA	—	—	—	—	—	1.2	0.0 (100)	0.0	0.0	100.0
RHODE ISLAND	15.0	10.0 (33.3)	5.0 (50.0)	5.0 (0)	56.7	—	—	—	—	—
S.C. CAROLINA	0.17	0.17 (0)	0.17 (0)	0.0 (100)	100.0	—	—	—	—	—
TEXAS	5.1	5.1 (0)	5.1 (0)	5.1 (0)	0.0	—	—	—	—	—
VIRGINIA ^k	0.5	0.38 (3.4)	0.34 (9.8)	0.24 (28.6)	52.0	—	—	—	—	—
WASHINGTON ^l	2.6	1.99 (23.4)	1.79 (9.8)	1.28 (28.6)	51.0	—	—	—	—	—
WISCONSIN	—	—	—	—	—	2.6	0.7 (73.1)	0.0 (100)	0.0	100.0

n.a. = No response available; — = Not applicable.

^aBase-year pollution is percentage of water area unavailable for swimming due to pollution in base period (table 4).

^bAverage percentage of water area unavailable for swimming due to pollution after implementation of best practicable technology.

^cSame measure after implementation of best available/best conventional technology.

^dSame measure after addition of best management practices for control of nonpoint sources.

^eTotal improvement = [(Base-year pollution limitation - Post BMP pollution limitation) / Base year pollution limitation] x 100.

^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

^gIndividual state was unable to estimate projections. We calculated an average percent change for each category and applied this to the state's base-year limitation estimate.

Table 9. Freshwater Swimming: Projected Pollution Limitation
Percentages and Improvements After Pollution Control

(All data in percent terms)

state	Base- Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e
ALABAMA	n.a.	n.a.	n.a.	n.a.	n.a.
ARIZONA	3.5	1.2 (65.7) ^f	1.2 (0) ^f	1.2 (0) ^f	65.7
ARKANSAS	45.0	45.0 (0)	45.0 (0)	29.6 (34.2)	34.2
CALIFORNIA	1.3	1.3 (0)	0.65 (50.0)	0.65 (0)	50.0
COLORADO	1.9	1.9 (0)	1.9 (0)	1.0 (47.4)	47.4
CONNECTICUT ^g	40.0	24.4 (39.0)	21.0 (14.0)	14.3 (32.0)	64.2
DELAWARE	18.8	9.2 (51.1)	9.2 (0)	8.1 (12.0)	56.9
FLORIDA	n.a.	n.a.	n.a.	n.a.	n.a.
GEORGIA	n.a.	n.a.	n.a.	n.a.	n.a.
IDAHO	14.0	9.2 (34.3)	8.8 (4.3)	5.5 (37.5)	60.7
ILLINOIS	4.8	2.0 (58.3)	2.0 (0)	2.0 (0)	58.3
INDIANA	n.a.	n.a.	n.a.	n.a.	n.a.
IOWA	50.0	38.5 (23.0)	30.4 (21.0)	18.8 (38.2)	62.4
KANSAS	2.5	2.0 (20.0)	1.0 (50.0)	0.5 (50.0)	80.0
KENTUCKY	9.5	5.0 (47.4)	1.0 (30.0)	1.0 (0)	89.5
LOUISIANA ^g	10.0	6.1 (39.0)	5.25 (14.0)	3.57 (32.0)	64.3
MAINE	1.0	0.0 (100)	0.0	0.0	100.0
MARYLAND	n.a.	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.
MICHIGAN	1.0	0.3 (70.0)	0.2 (33.3)	0.17 (15.0)	83.0
MINNESOTA	20.5	15.4 (24.9)	7.7 (50.0)	7.7 (0)	62.4
MISSISSIPPI	20.0	15.0 (25.0)	15.0 (0)	10.0 (33.3)	50.0
MISSOURI	3.5	2.8 (20.0)	2.2 (21.4)	1.6 (27.3)	54.3
MONTANA	0.0	0.0	0.0	0.0	0.0
NEBRASKA	20.5	19.5 (4.9)	16.6 (14.9)	11.6 (30.1)	43.4
NEVADA	n.a.	n.a.	n.a.	n.a.	n.a.
NEW HAMPSHIRE	12.4	3.0 (75.8)	3.0 (0)	0.3 (90.0)	97.6
NEW JERSEY	50.0	40.0 (20.0)	35.0 (12.5)	15.0 (57.1)	70.0

Table 9. (continued)

State	Base-Year Pollution ^a	Post BPT Pollution ^b	Post BAT Pollution ^c	Post BMP Pollution ^d	Total Improvement ^e
NEW MEXICO	0.4	0.3 (25.0) ^f	0.24 (20.0) ^f	0.15 (37.5) ^f	62.5
NEW YORK ^g	5.0	3.05 (39.0)	2.62 (14.0)	1.78 (32.0)	64.4
NO. CAROLINA	10.0	10.0 (0)	10.0 (0)	10.0 (0)	0.0
NO. DAKOTA	38.0	35.5 (6.6)	33.6 (5.3)	22.2 (33.9)	41.6
OHIO	20.0	20.0 (0)	15.0 (25.0)	12.0 (20.0)	40.0
OKLAHOMA	0.0	0.0	0.0	0.0	0.0
OREGON	0.5	0.5 (0)	0.5 (0)	0.5 (0)	0.0
PENNSYLVANIA	n.a.	n.a.	n.a.	n.a.	n.a.
RHODE ISLAND	n.a.	n.a.	n.a.	n.a.	n.a.
SO. CAROLINA ^g	4.5	2.7 (39.0)	2.36 (14.0)	1.6 (32.0)	64.4
SO. DAKOTA	40.0	30.0 (25.0)	25.0 (15.7)	15.0 (40.0)	62.5
TENNESSEE	3.3	2.3 (30.3)	2.2 (4.3)	2.2 (0)	33.3
TEXAS	30.8	11.8 (61.7)	10.0 (15.2)	10.0 (0)	67.5
UTAH	5.0	5.0 (0)	5.0 (0)	4.0 (20.0)	20.0
VERMONT	5.0	2.0 (50.0)	0.6 (70.0)	0.0 (100)	100.0
VIRGINIA	12.1	12.1 (0)	6.1 (49.5)	0.0 (100)	100.0
WASHINGTON	1.5	0.0 (100)	0.0	0.0	100.0
WEST VIRGINIA	n.a.	n.a.	n.a.	n.a.	n.a.
WISCONSIN	2.1	0.8 (61.9)	0.8 (0)	0.0 (100)	100.0
WYOMING	10.3	9.8 (4.8)	7.7 (21.4)	1.8 (76.6)	82.5

^an.a. = No response available.

^bBase-year pollution is percentage of water area unavailable for swimming due to pollution in base period (table 4).

^cAverage percentage of water area unavailable for swimming due to pollution after implementation of best practicable technology.

^dSame measure after implementation of best available/best conventional technology.

^eSame measure after addition of best management practices for control of nonpoint sources.

^fTotal improvement = $[(\text{Base-year pollution limitation} - \text{Post BMP pollution limitation}) / \text{Base-year pollution limitation}] \times 100$.

^gNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

^hIndividual state was unable to estimate projections. We calculated an average percent change for each category and applied this to the state's base-year limitation estimate.

Table 10. Marine Recreational Boating: Projected Pollution Limitation Percentages and Improvements in Bays and Estuaries After Pollution Control

(All data in percent terms)

	Small Boats					Bays and Estuaries				
	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base- Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
ALABAMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALIFORNIA ^g	0.5	0.36 (28.0) ^f	0.36 ^f (0)	0.24 (33.0) ^f	52.0	0.0	0.36 (28.0)	0.36 (0)	0.21 (33.0)	52.0
CONNECTICUT ^g	20.0	14.4 (28.0)	14.4 (0)	9.6 (33.0)	52.0	0.0	0.0	0.0	0.0	0.0
DELAWARE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLORIDA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GEORGIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LOUISIANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARYLAND	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	N.A.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.0	n.a.
MISSISSIPPI	30.0	22.0 (26.7)	22.0 (0)	10.0 (54.5)	66.7	0.0	0.0	0.0	0.0	0.0
NEW HAMPSHIRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW JERSEY	0.75	0.75 (0)	0.75 (0)	0.50 (33.3)	33.3	0.5	0.5 (0)	0.5 (0)	0.33 (33.3)	33.3
NEW YORK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NO. CAROLINA	2.5	2.5 (0)	2.5 (0)	2.5 (0)	0.0	2.5 (0)	2.5 (0)	2.5 (0)	2.5	0.0
OREGON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RHODE ISLAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO. CAROLINA	2.3	1.3 (43.5)	1.3 (0)	0.3 (76.9)	87.0	0.0	0.0	0.0	0.0	0.0
TEXAS	6.0	6.0 (0)	6.0 (0)	6.0 (0)	0.0	0.0	0.0	0.0	0.0	0.0
VIRGINIA ^g	0.5	0.36 (28.0)	0.36 (0)	0.24 (33.0)	52.0	0.5	0.36 (28.0)	0.36 (0)	0.21 (33.0)	52.0
WASHINGTON	0.1	0.0 (100)	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0

n.a. = No response available.

^aBase-year pollution is percentage of water area unavailable for boating due to pollution in base period (table 5).

^bAverage percentage of water area unavailable for boating due to pollution after implementation of best practicable technology.

^cSame measure after implementation of best available/best conventional technology.

^dSame measure after addition of best management practices for control of nonpoint sources.

^eTotal improvement = [(Base-year pollution limitation - Post BMP pollution limitation) / Base-year pollution limitation] x 100.

^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

^gIndividual state was unable to estimate projections. We calculated an average percent change for each category and applied this to the state's base-year limitation estimate.

Table 11. Marine Recreational Boating: Projected Pollution Limitation Percentages and Improvements in Coastal Waters After Pollution Control

(All data in percent terms)

State	Coastal									
	Small Boats					Large Boats				
	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base-Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
ALABAMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALIFORNIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONNECTICUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DELAWARE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLORIDA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GEORGIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LOUISIANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARYLAND	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MISSISSIPPI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW HAMPSHIRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW JERSEY	0.75	0.75 ^f (0)	0.75 ^f (0)	0.75 ^f (0)	0.0	0.5	0.5 (0)	0.5 (0)	0.5 (0)	0.0
NEW YORK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NO. CAROLINA	2.5	2.5 (0)	2.5 (0)	2.5 (0)	0.0	1.0	1.0 (0)	1.0 (0)	1.0 (0)	0.0
OREGON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RHODE ISLAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO. CAROLINA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEXAS	3.5	3.5 (0)	3.5 (0)	3.5 (0)	0.0	0.0	0.0	0.0	0.0	0.0
VIRGINIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WASHINGTON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

n.a. = No response available.

^aBase-year pollution is percentage of water area unavailable for boating due to pollution in base period (table 5).

^bAverage percentage of water area unavailable for boating due to pollution after implementation of best practicable technology.

^cSame measure after implementation of best available/best conventional technology.

^dSame measure after addition of best management practices for control of nonpoint sources.

^eTotal improvement = ((Base-year pollution limitation - Post BMP pollution limitation) / Base-year pollution limitation) x 100.

^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

Table 12. Great Lakes Recreational Boating: Projected Pollution Limitation Percentages and Improvements After Pollution Control

(All data in percent terms)

State	Small Boats					Large Boats				
	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base-Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
ILLINOIS	0.5	0.3 (40.0) ^f	0.3 (0) ^f	9.3 (0) ^f	40.0	0.5	0.3 (40.0)	0.3 (0)	0.3 (0)	40.0
INDIANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MICHIGAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MINNESOTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW YORK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
OHIO	1.0	1.0 (0)	1.0 (0)	1.0 (0)	0.0	0.0	0.0	0.0	0.0	0.0
PENNSYLVANIA	0.5	0.5 (0)	0.5 (0)	0.5 (0)	0.0	0.5	0.5 (0)	0.5 (0)	0.5 (0)	0.0
WISCONSIN	0.2	0.0 (100)	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0

n.a. = No response available.

^aBase-year pollution is percentage of water area unavailable for boating due to pollution in base period (table 5).

^bAverage percentage of water area unavailable for boating due to pollution after implementation of best practicable technology.

^cSame measure after implementation of best available/best conventional technology.

^dSame measure after addition of best management practices for control of nonpoint sources.

^eTotal improvement = ((Base-year pollution limitation - Post BMP pollution limitation) / Base-year pollution limitation) x 100.

^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

Table 13. Freshwater Recreational Boating: Projected Pollution Limitations Percentages and Improvements After Pollution Control
(All data in percent terms)

State	Small Boats					Large Boats				
	Base-Year Pollu- tion ^a	Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base- Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
ALABAMA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ARIZONA	n.a.	n.a.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARKANSAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALIFORNIA	0.25	0.12 (52.0) ^f	0.09 (25.0) ^f	0.06 (33.3) ^f	76.0	0.25	0.12 (52.0)	0.09 (25.0)	0.06 (33.3)	76.0
COLORADO	2.0	0.0 (100)	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
CONNECTICUT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DELAWARE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLORIDA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
GEORGIA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IDAHO	11.5	7.3 (36.5)	6.2 (15.1)	2.2 (64.5)	80.9	4.2	2.7 (35.7)	2.3 (14.0)	0.8 (65.3)	81.0
ILLINOIS	11.0	11.0 (0)	11.0 (0)	11.0 (0)	0.0	11.0	11.0 (0)	11.0 (0)	11.0 (0)	0.0
INDIANA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IOWA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KANSAS	2.5	2.5 (0)	2.5 (0)	1.0 (60.0)	60.0	2.5	2.5 (0)	2.5 (0)	1.0 (60.0)	60.0
KENTUCKY	1.0	1.0 (0)	1.0 (0)	1.0 (0)	0.0	1.0	1.0 (0)	1.0 (0)	1.0 (0)	0.0
LOUISIANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINE	2.0	0.0 (100)	0.0	0.0	100.0	1.0	0.0 (100)	0.0	0.0	100.0
MARYLAND	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MICHIGAN	0.1	0.0 (100)	0.0	0.0	100.0	0.0	0.0	0.0	n.a.	0.0
MINNESOTA	10.0	10.0 (0)	10.0 (0)	10.0 (0)	0.0	10.0	10.0 (0)	10.0 (0)	10.0 (0)	0.0
MISSISSIPPI	20.0	15.0 (25.0)	15.0 (0)	10.0 (33.3)	50.0	0.0	0.0	0.0	0.0	0.0
MISSOURI	0.5	0.5 (0)	0.0 (100)	0.0	100.0	0.5	0.5 (0)	0.0 (100)	0.0	100.0
MONTANA	2.5	2.0 (20.0)	1.5 (25.0)	0.7 (53.3)	72.0	2.5	2.0 (20.0)	1.5 (25.0)	0.7 (53.3)	72.0
NEBRASKA	25.0	13.8 (44.8)	9.0 (34.8)	8.1 (10.0)	67.6	5.0	2.8 (44.0)	1.8 (35.7)	1.6 (11.1)	68.0
NEVADA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NEW HAMPSHIRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW JERSEY	10.0	10.0 (0)	8.0 (20.0)	5.0 (31.5)	50.0	10.0	10.0 (0)	0.0 (20.0)	5.0 (37.5)	50.0
NEW MEXICO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEW YORK	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NO. CAROLINA	7.5	1.5 (0)	7.5 (0)	7.5 (0)	0.0	5.0	5.0 (0)	5.0 (0)	5.0 (0)	0.0

Table 13. (continued)

State	Base-Year Pollu- tion ^a	Small Boats				Large Boats				
		Post BPT Pollu- tion ^b	Post BAT Pollu- tion ^c	Post BMP Pollu- tion ^d	Total Improve- ment ^e	Base- Year Pollu- tion	Post BPT Pollu- tion	Post BAT Pollu- tion	Post BMP Pollu- tion	Total Improve- ment
NO. DAKOTA	5.0	5.0 (0) ^f	3.0 (40.0) ^f	0.0 (100) ^f	100.0	0.0	0.0	0.0	0.0	0.0
OHIO	15.0	85.0 (0)	10.0 (33.3)	2.0 (80.0)	86.7	3.0	3.0 (0)	2.0 (33.3)	0.4 (80.0)	86.7
OKLAHOMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OREGON	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PENNSYLVANIA	15.0	0.0 (100)	0.0	0.0	100.0	10.0	0.0 (100)	0.0	0.0	100.0
RHODE ISLAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
SO. CAROLINA	3.0	1.0 (66.7)	1.0 (0)	0.33 (66.7)	89.0	0.0	0.0	0.0	0.0	0.0
SO. DAKOTA	5.0	5.0 (0)	5.0 (0)	4.0 (20.0)	20.0	5.0	5.0 (0)	5.0 (0)	4.0 (20.0)	20.0
TENNESSEE	0.55	0.55 (0)	0.55 (0)	0.55 (0)	0.0	0.0	0.0	0.0	0.0	0.0
TEXAS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UTAH	5.0	5.0 (0)	5.0 (0)	0.0 (100)	100.0	5.0	5.0 (0)	5.0 (0)	0.0 (100)	100.0
VERMONT	2.0	1.0 (50.0)	0.5 (50.0)	0.0 (100)	100.0	0.0	0.0	0.0	0.0	0.0
VIRGINIA	8.7	1.8 (79.3)	0.0 (100)	0.0	100.0	2.0	0.4 (80.0)	0.0 (100)	0.0	100.0
WASHINGTON	1.0	0.0 (100)	0.0	0.0	100.0	1.0	0.0 (100)	0.0	0.0	100.0
WEST VIRGINIA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
WISCONSIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WYOMING	5.0	5.0 (0)	5.0 (0)	3.2 (36.0)	36.0	5.0	5.0 (0)	5.0 (0)	3.2 (36.0)	36.0

n.a. = No response available.

^aBase-year pollution is percentage of water area unavailable for boating due to pollution in base period (table 5).^bAverage percentage of water area unavailable for boating due to pollution after implementation of boat practicable technology.^cSame measure after implementation of best available/best conventional technology.^dSame measure after addition of best management practices for control of nonpoint sources.^eTotal improvement = ((Base-year pollution limitation - Post BMP pollution limitation) / Base-year pollution limitation) x 100.^fNumbers in parentheses reflect the incremental percent change in pollution limited area after full implementation of each stage of the Clean Water Act requirements.

Table 14. Summary of Average Improvements By Water Category Control Stage and Activity.

(All data in percent terms)

Marine		Great Lakes		Freshwater
<u>Bays/Estuarine</u>		<u>Coastal</u>		
<u>Recreational</u>				
<u>Fishing</u>	(N=14)	(N=4)	(N=7)	
BPT	37.1	13.4	57.5	--
BAT	21.0	16.7	25.0	--
BMP	14.3	28.5	47.0	--
Total	57.0	35.6	83.1	--
<u>Swimming</u>				
	(N=14)		(N=6)	(N=36)
BPT	23.4		78.8	39.0
BAT	9.8		20.0	14.0
BMP	28.6		0	32.0
Total	52.5		86.7	64.0
<u>Boating</u>				
	(N=9)	(N=3)	(N=4)	(N=26)
(Small boats)				
BPT	28.0	0	35.5	33.6
BAT	0	0	0	17.0
BMP	33.0	0	0	30.6
Total	52.0	0	35.0	64.9
(Large boats)	(N=4)	(N=2)	(N=2)	(N=19)
BPT	14.0	0	20.0	28.0
BAT	0	0	0	18.6
BMP	25.0	0	0	26.1
Total	34.3	0	20.0	60.5

As a review of tables 6 through 13 will disclose, the improvements attributed by states to the several implementation stages in general vary widely. This combination of small numbers of observations and wide variability in those observations combine to reduce the real significance of the apparent patterns to be found in the summary table.¹⁰ In fact, on the basis of the test referred to in footnote 10, only in three of the water activity categories is it possible to be confident that the average incremental improvements are really different for the different stages. These three are marine and freshwater swimming, and small boating in bays and estuaries.

Pollution control by definition can only reduce restrictions on availability due to pollution. But as we have noted, significant percentages of some states' inters and shorelines are considered unavailable for one or another category of recreation because of such conditions as lack of physical access, waters too cold for contact sports, or extreme currents. To put the pollution control improvements in perspective, then, it is useful to examine how total availability is projected to change with implementation of all stages of CWA. These results are summarized in tables 15 through 19. To make clear what role pollution control can potentially play, we indicate by footnotes whether or not pollution was causing restricted availability in the base-year and whether or not any such restriction is projected to remain after full implementation of CWA.

One thing these tables show is that often even full implementation of pollution control laws now on the books will make only a small difference in the fraction of a state's water area or shoreline available for a particular

10. The reader interested in statistics and formal tests of significance say pursue the question of apparent versus real patterns in the summary results using a non-parametric test such as that of Friedman. See Conover, W. J., Practical Nonparametric Statistics 2nd edition (New York, N.Y., Wiley, 1980).

Table 15. Percent of Total Water Areas Available to Recreational Fishing Before (Base-Year) and After Full Implementation of the Clean Water Act (CWA)

(All data in percent terms)

State	Marine				Great Lakes	
	Bays & Estuaries		Coastal		Base-Year Avail- able ^a	Projected Post-CWA Avail- able ^c
	Base-Year Avail- able ^a	Projected Post-CWA Avail- able	Base-Year Avail- able ^a	Projected Post-CWA Avail- able ^b		
ALABAMA	87.5	89.5	100.0 ^d	100.0	--	--
CALIFORNIA	100.0 ^d	100.0	98.4 ^d	98.4	--	--
CONNECTICUT	25.0	41.3	100.0 ^d	100.0	--	--
DELAWARE	100.0 ^d	100.0	100.0 ^d	100.0	--	--
FLORIDA	77.5	80.4	95.0 ^d	95.0	--	--
GEORGIA	99.0	99.0	100.0 ^d	100.0	--	--
ILLINOIS	--	--	--	--	66.2	91.5
INDIANA	--	--	--	--	n.a.	n.a.
LOUISIANA	65.0 ^d	65.0	65.0	65.0	--	--
MAINE	95.0	97.9	99.0	99.4	--	--
MARYLAND	100.0 ^d	100.0	100.0 ^d	100.0	--	--
MASSACHUSETTS	99.0	99.6	100.0 ^d	100.0	--	--
MICHIGAN	--	--	--	--	99.0	100.0 ^e
MINNESOTA	--	--	--	--	98.0	100.0 ^e
MISSISSIPPI	85.0	90.0	100.0	100.0	--	--
NEW HAMPSHIRE	100.0 ^d	100.0	100.0 ^d	100.0	--	--
NEW JERSEY	92.6	97.1	92.4	94.4	--	--
NEW YORK	92.5	96.8	100.0 ^d	100.0	20.0	86.5
NO. CAROLINA	77.5	87.5	95.0	95.0	--	--
OHIO	--	--	--	--	75.0	80.0
OREGON	83.0	90.0 ^e	100.0	100.0	--	--
PENNSYLVANIA	--	--	--	--	90.0	99.0
RHODE ISLAND	100.0	100.0	100.0	100.0	--	--
SO. CAROLINA	88.3	97.7	100.0 ^d	100.0	--	--
TEXAS	87.4	88.7	92.5	93.5	--	--
VIRGINIA	85.0	100.0 ^e	100.0 ^d	100.0	--	--
WASHINGTON	94.5	94.8	100.0 ^d	100.0	--	--
WISCONSIN	--	--	--	--	65.5	100.0 ^e

n.a. = No response available; - = Not applicable.

^aBase-year availability from table 3.

^bImprovement to post-CWA availability from table 6.

^cImprovement to post-CWA availability from table 7.

^dNo pollution-related limitations prior to CWA implementation.

^eNo pollution-related limitations after full CWA implementation.

Table 16. Percent of Total Water Areas Available to Swimming Before (Base-Year) and After Full Implementation of the Clean Water Act (CWA)

(All data in percent terms)

state	Freshwater		Marine		Great Lakes	
	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^c	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^b	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^b
ALABAMA	n.a.	n.a.	89.7	89.95	--	--
ARIZONA	59.0	61.3	--	--	--	--
ARKANSAS	55.0	70.4	--	--	--	--
CALIFORNIA	93.5	94.2	n.a.	n.a.	--	--
COLORADO	10.0	10.9	--	--	--	--
CONNECTICUT	50.0	75.7	53.1	59.8	--	--
DELAWARE	15.0	25.7	100.0 ^d	100.0	--	--
FLORIDA	n.a.	n.a.	100.0 ^d	100.0	--	--
GEORGIA	n.a.	n.a.	91.4 ^d	91.4	--	--
IDAHO	70.0	78.5	--	--	--	--
ILLINOIS	57.0	69.8	--	--	85.3	100.0 ^e
INDIANA	n.a.	n.a.	--	--	90.0	100.0 ^e
IOWA	40.0	71.2	--	--	--	--
KANSAS	50.0	52.0	--	--	--	--
KENTUCKY	70.0	78.5	--	--	--	--
LOUISIANA	80.0	86.4	30.0	35.0	--	--
MAINE	74.0	75.0 ^c	98.0	99.0 ^e	--	--
MARYLAND	n.a.	n.a.	24.9	24.97	--	--
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	--	--
MICHIGAN	99.0	99.8	--	--	99.0	100.0 ^e
MINNESOTA	79.5	92.3	--	--	100.0 ^d	100.0
MISSISSIPPI	40.0	50.0	10.0	35.0	--	--
MISSOURI	62.4	64.3	--	--	--	--
MONTANA	99.0 ^d	99.0	--	--	--	--
NEBRASKA	42.0	50.9	--	--	--	--
NEVADA	n.a.	n.a.	--	--	--	--
NEW HAMPSHIRE	87.5	99.4	100.0 ^d	100.0	--	--
NEW JERSEY	40.0	75.0	74.6	83.1	--	--
NEW MEXICO	98.7	99.0	--	--	--	--
NEW YORK	95.0	98.2	20.0	50.5	n.a.	n.a.
NO. CAROLINA	42.0	42.0	95.0	95.0	--	--
NO. DAKOTA	38.0	53.8	--	--	--	--
OHIO	55.0	63.0	--	--	75.5	77.5
OKLAHOMA	95.0 ^d	95.0	--	--	--	--
OREGON	39.5	39.5	85.0 ^d	85.0	--	--
PENNSYLVANIA	n.a.	n.a.	--	--	98.8	100.0 ^e
RHODE ISLAND	n.a.	n.a.	85.0	85.0	--	--
SO. CAROLINA	95.5	98.4	99.3	100.0 ^e	--	--
SO. DAKOTA	40.0	65.0	--	--	--	--
TENNESSEE	52.7	53.8	--	--	--	--
TEXAS	69.2	90.0	37.4	37.4	--	--
UTAH	90.0	91.0	--	--	--	--
VERMONT	95.0	100.0 ^e	--	--	--	--
VIRGINIA	82.9	95.0 ^e	95.3	96.0	--	--
WASHINGTON	91.0	92.5 ^e	47.5	48.8	--	--
WEST VIRGINIA	n.a.	n.a.	--	--	--	--
WISCONSIN	62.1	64.2 ^e	--	--	14.4	17.0 ^e
WYOMING	15.8	24.3	--	--	--	--

n.a. = No response available; - = Not applicable.

^aBase-year availability from table 4.

^bImprovement to post-CWA availability from table 8.

^cImprovement to post-CWA availability from table 9.

^dNo pollution-related limitations prior to CWA implementation.

^eNo pollution-related limitations after full CWA implementation.

Table 17. Percent of Total Water Area Available to Marine Recreational Boating Before (Base-Year) and After Full Implementation of the Clean Water Act (CWA)

(All data in percent terms)

	Bays & Estuaries				Coastal			
	Small Boats		Large Boats		Small Boats		Large Boats	
	Base Year Avail- able ^a	Projected Post-CWA Avail- able ^b	Base Year Avail- able ^a	Projected Post-CWA Avail- able ^b	Base Year Avail- able ^a	Projected Post-WA Avail- able ^c	Base Year Avail- able ^a	Projected Post-WA Avail- able ^c
ALABAMA	100.0	100.0	85.0	85.0	100.0	100.0	100.0	100.0
CALIFORNIA	99.0 ^d	99.3 ^e	99.0 ^d	99.3 ^e	100.0	100.0	100.0	100.0
CONNECTICUT	80.0 ^d	90.4 ^e	100.0	100.0	100.0	100.0	100.0	100.0
DELAWARE	100.0	100.0	95.0	95.0	100.0	100.0	100.0	100.0
FLORIDA	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GEORGIA	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
LOUISIANA	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MAINE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MARYLAND	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
MISSISSIPPI	50.0 ^d	70.0 ^e	60.0	60.0	100.0	100.0	60.0	60.0
NEW HAMPSHIRE	90.0	90.0	75.0	75.0	100.0	100.0	100.0	100.0
NEW JERSEY	97.0 ^d	97.25 ^e	97.0 ^d	97.2 ^e	97.0 ^d	97.0 ^e	97.0 ^d	97.0 ^e
NEW YORK	n.a.	n.a.	n.a. ^d	n.a.	n.a. ^d	n.a.	n.a. ^d	n.a.
NO. CAROLINA	97.5 ^d	97.5 ^e	97.5 ^d	97.5 ^e	97.5 ^d	97.5 ^e	99.0 ^d	99.0 ^e
OREGON	95.0	95.0	95.0	95.0	100.0	100.0	100.0	100.0
RHODE ISLAND	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SO. CAROLINA	97.7 ^d	99.7 ^e	100.0	100.0	100.0	100.0	100.0	100.0
TEXAS	86.5 ^d	86.5 ^e	92.5	92.5	91.5 ^d	91.5 ^e	95.0	95.0
VIRGINIA	99.5 ^d	99.8 ^e	99.5 ^d	99.8 ^e	100.0	100.0	100.0	100.0
WASHINGTON	82.9 ^d	83.0	99.3	99.3	66.3	66.3	99.7	99.7

^an.a. = No response available.

^bBase-year availability from table 5.

^cImprovement to post-CWA availability from table 10.

^dImprovement to post-CWA availability from table 11.

^eSome pollution-related limitations before CWA implementation.

^fSome pollution-related limitations remaining even after full implementation of CWA.

Table 18. Percent of Total Water Areas Available to Great Lakes Recreational Boating Before (Base-Year) and After Full Implementation of the Clean Water Act (CWA)

(All data in percent terms)

State	Small Boats		Large Boats	
	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^b	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^b
ILLINOIS	32.0 ^c	32.2 ^d	79.5 ^c	79.7 ^d
INDIANA	100.0	100.0	100.0	100.0
MICHIGAN	100.0	100.0	100.0	100.0
MINNESOTA	100.0	100.0	100.0	100.0
NEW YORK	n.a.	n.a.	n.a.	n.a.
OHIO	95.0 ^c	95.0 ^d	100.0	100.0
PENNSYLVANIA	64.5 ^c	64.5 ^d	74.0 ^c	74.0 ^d
WISCONSIN	99.8 ^c	100.0	100.0	100.0

n.a. = No response available.

^aBase-year availability from table 5.

^bImprovement to post-CWA availability from table 12.

^cSome Pollution-related limitations before CWA implementation.

^d~~Some~~ pollution-related limitations remaining even after full implementation of CWA.

Table 19. Percent of Total Water Area Available to Freshwater Recreational Boating Before (Base-Year) and After Full Implementation of the Clean Water Act (CWA)
(All data in percent terms)

State	Small Boats		Large Boats	
	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^b	Base-Year Avail-able ^a	Projected Post-CWA Avail-able ^b
ALABAMA	n.a.	n.a.	n.a.	n.a.
ARIZONA	76.2	76.2	80.5	80.5
ARKANSAS	95.0	95.0	62.5	62.5
CALIFORNIA	94.5 ^c	94.7 ^d	37.0 ^c	37.2 ^d
COLORADO	98.0 ^c	100.0	100.0	100.0
CONNECTICUT	80.0	80.0	60.0	60.0
DELAWARE	80.0	80.0	5.0	5.0
FLORIDA	n.a.	n.a.	n.a.	n.a.
GEORGIA	n.a.	n.a.	n.a.	n.a.
IDAHO	78.5 ^c	87.8 ^d	75.8 ^c	79.2 ^d
ILLINOIS	69.0 ^c	69.0 ^d	49.0 ^c	49.0 ^d
INDIANA	n.a.	n.a.	n.a.	n.a.
IOWA	90.0	90.0	30.0	30.0
KANSAS	50.0 ^c	61.5 ^d	27.5 ^c	29.0 ^d
KENTUCKY	39.0 ^c	39.0 ^d	39.0 ^c	39.0 ^d
LOUISIANA	00.0	100.0	100.0	100.0
MAINE	96.0 ^c	98.0	94.0 ^c	95.0
MARYLAND	n.a.	n.a.	n.a.	n.a.
MASSACHUSETTS	n.a.	n.a.	n.a.	n.a.
MICHIGAN	94.9 ^c	95.0	95.0	95.0
MINNESOTA	90.0 ^c	90.0 ^d	90.0 ^c	90.0 ^d
MISSISSIPPI	40.0 ^c	50.0 ^d	40.0	40.0
MISSOURI	95.0 ^c	85.5	80.0 ^c	80.5
MONTANA	97.5 ^c	99.3 ^d	97.5 ^c	99.3 ^d
NEBRASKA	30.0 ^c	46.9 ^d	50.0 ^c	53.4 ^d
NEVADA	n.a.	n.a.	n.a.	n.a.
NEW HAMPSHIRE	97.0	97.0	97.0	97.0
NEW JERSEY	60.0 ^c	65.0 ^d	40.0 ^c	45.0 ^d
NEW MEXICO	87.0	87.0	77.0	77.0
NEW YORK	n.a.	n.a.	n.a.	n.a.
NO. CAROLINA	92.5 ^c	92.5 ^d	92.5 ^c	92.5 ^d
NO. DAKOTA	75.0 ^c	80.0	70.0	70.0
OHIO	65.0 ^c	78.0 ^d	37.0 ^c	39.6 ^d
OKLAHOMA	95.0	95.0	95.0	95.0
OREGON	96.5	96.5	96.5	96.5
PENNSYLVANIA	75.0 ^c	90.0	30.0 ^c	30.0
RHODE ISLAND	90.0	90.0	90.0	90.0
SO. CAROLINA	97.0 ^c	99.7 ^d	100.0	100.0
SO. DAKOTA	90.0 ^c	91.0 ^d	35.0 ^c	36.0 ^d
TENNESSEE	93.4 ^c	93.4 ^d	91.0	91.0
TEXAS	100.0	100.0	100.0	100.0
UTAH	85.0 ^c	90.0	35.0 ^c	30.0
VERMONT	98.0 ^c	100.0	100.0	100.0
VIRGINIA	79.6 ^c	88.3	78.0 ^c	80.0
WASHINGTON	98.5 ^c	99.5	94.0 ^c	95.0
WEST VIRGINIA	n.a.	n.a.	n.a.	n.a.
WISCONSIN	45.8	45.8	40.3	40.8
WYOMING	80.0 ^c	81.8 ^d	70.0 ^c	71.3 ^d

n.a. = No response available.

^aBase-year availability from table 5.

^bImprovement to post-CWA availability from table 13.

^cSome pollution-related limitations before CWA implementation.

^dSome pollution-related limitations remaining even after full implementation of CWA.

recreational activity. Data uncorrected for this aspect of availability will be misleading as a guide to the supply of recreational water area and shoreline. However, it is also true that in a few states and for some activity/water category combinations, full implementation of CWA is projected to make really enormous differences. For example, after full CWA implementation Connecticut's availability of bays and estuaries for marine recreational fishing is projected to increase by 65 percent. Iowa's freshwater swimming (shoreline) availability is projected to increase by 62 percent. And water for small boating in the bays and estuaries of Mississippi will go up by 67 percent.

Section IV. SUMMARY AND CONCLUSIONS

Average estimates from the survey indicate that opportunities to participate in water-related recreational activities during 1974-76 were not greatly limited by pollution. In percentage terms, availability for swimming was most affected, followed by that for fishing--specifically in the Great Lakes. As might be expected, boating opportunities were hardly affected at all, with the greatest pollution problems relating to use of small boats.

Because they have different pollution problems, projected levels of improvement after each stage of the Clean Water Act varied widely among the states. The projection estimates did suggest, however, that the largest percent improvement in availability for most activity/water category combinations would be attained by implementation of the first stage--BPT.

It seemed that implementation of BAT/BCT would generally have the least effect of the three stages on recreational categories. The overall pattern of results from application of best management practices was mixed. More often than not, the average, improvement attributed by respondents to BMP was less than that attributed to BPT but greater than that for BAT. But in a few activity/water category combinations, BMP was projected to have a greater

incremental impact than BPT. Total reductions in pollution restrictions, reflecting all three phases of CWA implementation, as averaged over the applicable states, ranged from zero (boating in marine coastal waters) to almost 90 percent (shoreline miles suitable for swimming on the Great Lakes).